DOCUMENT NO. 44.

BOARD OF ALDERMEN

FEBRUARY 16, 1835.

The following report was received from the Commissioners appointed, pursuant to a Law passed by the Legislature, on the 2d of May, 1834, *in relation to supplying the City of New-York with pure and wholesome water, which was referred to the Committee on Fire and Water, and* 2500 *copies directed to be printed, together with the Documents accompauying the same, and the drawings lithographed.*

J. MORTON, Clerk.

To the Honorable the Common Council of the City of New-York.

The Water Commissioners appointed under the Act of the Legislature of this State, entitled, " An Act for supplying the City of New-York, with pure and wholesome water," passed the 2d of May, 1834, respectfully

REPORT:

That the undersigned were appointed Commissioners, under an Act of the Legislature, entitled, " an Act for the appoint-

ment of Commissioners, in relation to supplying the City of New-York with pure and wholsome water," passed February 26th 1833, and that on the 12th of November, of the same year, they had the honor of submiting to the Common Council a report, in which they recommended the Croton River as the only sure source of supply ; both on account of its capacity and the purity of its waters. Two plans were proposed for conducting the water by aqueduct to the City, one through the interior of the County of Westchester, by the valley of the Saw-mill River, and the other, through the vallies of the Croton and Hudson Rivers, until the two lines meet a few miles east of the village of Yonkers.

They avoided, for the reasons stated in the report alluded to, making any selection of the route preferred between the interior and Hudson River routes, presuming that the main object of their appointment was to ascertain,

1st. Whether a sufficient quantity of good and wholesome water could be obtained for present and all future purposes.

2d. The practicability of its introduction into the City, at an elevation that would preclude the use of machinery, and

3d. The total cost of completing the projected work.

It will be seen, as they think, by a reference to their report of November, 1833, that they have conclusively shown, that the supply from the Croton will be abundant, the quality of the water unquestionable, and the facility of introduction beyond dispute.

The act under which they hold their present appointment requires of them,

1st. To examine and consider all matters relative to supplying the City of New-York with a sufficient quantity of pure and wholesome water ; to adopt such plan, as in their opinion will be most advantageous for securing such supply, and to report a full statement and description of the plan adopted by them.

2d. To ascertain, as near as may be, what amount of money may be necessary to carry the same into effect.

3d. To report an estimate of the probable amount of revenue

that will accrue to the City, upon the completion of the work, and the reasons and calculations upon which their opinion and estimates may be founded; such report to be made and presented to the Common Council of this City, on or before the first day of January, 1836.

The Commissioners have presumed, however, that a paramount object of their reappointment, was a close and thorough re-examination, under such additional lights, as time and further reflection may have produced, of the plans they have proposed, and of the estimates they have entered into, extending their inquiries to any new matter alluded to by the act of the Legislature, referred to them by the Common Council, or suggested to them by others, for effecting the object in view, or, as improvements upon the plans and estimates proposed by their former report.

With these views of what would be required of them, and in order to test the correctness of the plans proposed by their report of November, 1833, the Commissioners engaged David B. Douglas, Esq. to re-examine his surveys, levels and calculations, and to ascertain whether lines for an aqueduct may not be designated that will require less labor and expense, than those recommended by the report of 1833; whether a more economical method of constructing the aqueduct may not be adopted; whether the cost of building culverts, and bridges, making excavations and embankments, erecting the reservoirs, estimating the damages to water rights, &c. may not be reduced; whether the expense of equalizing reservoirs may not be dispensed with, and finally, whether the waters of the Croton may not be introduced from some different head, or by some other method, and at a much less cost, than that estimated in the report of 1833.

On the 31st of December, 1833, something more than a month after we had presented our report to the Common Council, Mr. D. S. Rhodes addressed a communication to the Board of Aldermen, proposing for one million seven hundred thousand dollars, to introduce, through iron pipes, from the mouth of the Croton River, six million gallons of water every twenty-four hours; and for two million seven hundred thousand dollars, to

inroduce sixteen million of gallons into the City of New-York, at an elevation of 125 feet above low water, (see Corporation Document No. 54); he presented another communication on the 6th of January, 1834, objecting to the plan proposed by our Engineer in 1833, for conducting the waters of the Croton to the City, stating, " that the most serious objection he has to urge against the plan is, that the water, however pure it may be at the fountain head, must inevitably become contaminated with some deliterious substance, passing over such a variety of soils, and amalgamating so many mineral substances." He then proposes constructing a dam near the Quaker's Bridge, on the Croton River, 45 feet high, which will give an elevation or head of 125 feet above tide of the Hudson; " from this dam the pipes will rise gradually until they pass Sing Sing," and from thence descend to the shores of the Hudson, which, (as he states) " forms almost a straight line to the City, and very few obstacles to overcome; the Harlaem River will be crossed at very little expense," (see Document No. 57.)

On the 20th of January, 1834, Mr. Rhodes addressed a letter to the Chairman of the Commissioners, in which he says, " The natural butments and high hills near the Quaker's Bridge, will give an elevation of 200 feet above the tide, if required. The canal to Sleepy Hollow will be on a level with the dam, which gives us the same head at Sleepy Hollow as we have at the dam. By my plan we arrive at Sleepy Hollow, travelling only eight miles with the whole of the Croton."

On the 18th of April, 1834, Mr. Rhodes addressed a communication to the Committee of the Common Council " on Fire and Water," in which he proposes to build a dam, at a point about four miles above the Quaker's Bridge, of 32 feet high. From this he is to take the water in a canal 10 feet at bottom, 34 feet at top, and 8 feet in depth, on the same line nearly as that proposed for the Hudson River route, in our report of November, 1833, to a reservoir near Harlaem River and from said reservoir to cross Harlaem River by iron pipes, to the receiving and distributing reservoir on the island of New-York; the Corporation to pay all damages for water and land rights,

and $1,700,000 in cash, when the work is finished according to contract; but to allow him interest as the work progresses, (see Document No. 109).

It will not be expected, as we presume, either by Mr. Rhodes or by the Common Council, that the Commissioners should place much reliance upon the plans and propositions of a gentleman, who appears to have given the subject but a very superficial consideration at most.

How he is to convey either six or sixteen millions of gallons of water from the mouth of the Croton, in accordance with his first proposition, and at an elevation of 125 feet above low water, at the City of New-York, it would puzzle the most expert proficient in hydraulics to tell.

By his communication of the 6th of January, 1834, he proposes raising a dam of 45 feet in height, near the Quaker's Bridge, which is two or three miles above the mouth of the Croton, from whence the water was to be taken, as first contemplated. From this dam the water is to be carried in iron pipes, and to rise gradually until they pass Sing Sing, and from thence descend to the shores of the Hudson, and so on to the City. He states that these shores "form a straight line, and very few obstacles to overcome;" but the map of the river shows several promontaries and bays, with no less than sixteen streams, some of considerable magnitude, to be passed. When he states that the water can be delivered in the City, at an elevation of 125 feet, while his fountain is only of that height; that the pipes will rise gradually until they pass Sing Sing, which, in effect, would be making water run up hill, and that he will deliver six millions of gallons of water, in iron pipes, for $1,700,000, when the lowest calculation for laying a line of 30-inch pipes, 40 miles in length, will cost $2,798,400, and will only deliver about three millions of gallons every twenty-four hours; we ask, what confidence can be placed in the calculations and estimates of the proposer?

By his letter of the 20th of January, 1834, he says, his canal to Sleepy Hollow will be on a level with the dam; and by this canal, having no descent whatever, he calculates to be enabled

to carry the whole of the river for eight miles, and thus continue the same elevation at the end of this eight miles, that he has at his fountain!!

By his communication of the 18th April, 1834, he makes a total change in his projects, and states that he will build a dam about four miles above the Quaker's Bridge, of 32 feet in height, and from thence conduct the water, by an open canal of 10 feet bottom, 34 feet top, and 8 feet deep, to the height near Harlaem River. His first proposition was, to take the water from the mouth of the river; second, from near the Quaker's Bridge; and third, at Garritson's Mill, about four miles above the said bridge. Now, although this last proposition carries with it the semblance of feasability, there is, nevertheless, nothing new in it; for he only offers to remove the dam from the place selected by our engineer, to a position some miles below it, while he follows the precise line designated by our report, and adopts the very objectionable plan of carrying the water in a large open canal, instead of a closed aqueduct of masonry as proposed by us. His objections to the aqueduct proposed by our report, on account of the water running through it becoming contaminated with some deleterious substances, and his decided preference to iron pipes, appear to have departed from his memory altogether; for he now recommends an open canal of large dimensions, subject, as it would be, to the numberless casualties incident to such constructions; besides being the receptacle of much filth in its long passage, the wash of the country, and the dissolvent of the mineral and other substances combined with the earth through which it passes. The complaint raised in London against the water of the New River is, "that being an open canal, it is subject to the drainage of the country through which it runs, in consequence of a right claimed by the proprietors of the adjacent lands, and which the company have no means of obviating. neither have they any power to prevent persons from bathing in their aqueduct." Mr. Rhodes, however, has altogether misconceived the construction of the aqueduct proposed by our report, for instead of its admitting any of these substances or impurities, it was to be impervious

on three sides to any external fluid or substance whatever, and on the fourth, the proposition was, to have it covered with a board or shingle roof.

These several inconsistencies have tended to destroy the confidence of the Commissioners in the projects of Mr. Rhodes; and they would not have spent so much time on their examination, had it not been their opinion, that the Common Council would expect some notice of a proposition that offered to effect the important object of supplying this City with pure and wholesome water, at a cost two thirds less than that estimated by our engineer, in his report of 1833. They have, therefore, deemed it their duty, to ascertain by actual survey, whether a dam may not be raised at some point nearer the mouth of the river, than that proposed by their report of 1833, from which might be drawn an equal quantity of water, and at the same time save much in the expenditure.

To effect the aforesaid object the Commissioners engaged John Martineau, Esq. Civil Engineer, to make the necessary surveys, levels, and estimates, having special reference to the erection of a lofty dam at some station on the river nearer its mouth than the place selected by Major Douglass; to ascertain the damage that would ensue by overflowing the land and injuring the mill seats; and to estimate the expense of erecting such dam and compensating those injuries; to ascertain and report the best plan for conveying the water from said dam to the City: the quantity per diem that will be conveyed by the plan recommended; the cost of the necessary excavations, embankments, bridges, culverts and reservoirs, required to deliver the water, on a declivity of fifteen inches to the mile, to a receiving reservoir on the high grounds near Harlaem River, and from thence across said river to another reservoir of sufficient elevation, near Manhattanville (should he be of opinion that these reservoirs will be necessary) then to a distributiug reservoir three or four miles from the City Hall, near 38th street and the 5th Avenue, preserving an elevation of 117 to 120 feet above tide at said reservoir; but if any of the reservoirs named can be dispensed with, or

if additional ones be required, to report the reasons why, and to conform the estimate to the alterations in the plan, should any be recommended. To furnish a report in writing, with a profile and map of the survey, showing the water line of the basin formed by the dam; the land that will be overflowed on both sides of the river; the line traced for the aqueduct; the depth of excavations and the height of embankments, &c. in order that a plain and comprehensive view of the whole subject may be given. To ascertain whether the cost of erecting a high dam, at or near Garritson's mill, and the consequent damage that will accrue by the overflowing of the land and injuring mill privileges, will be greater than the cost of taking the water from a higher source up the river.

The Commissioners have also employed George W. Cartwright, Esquire, a Civil Engineer, residing at the village of Sing Sing, and who possesses much local knowledge of the Croton and its vicinity, to run levels on both sides of said river, starting from Garritson's mill, at a height of thirty-eight feet, and carrying his levels up until they loose themselves at the surface of the water, in order to ascertain what quantity of land would be overflowed with water by the erection of a high dam at the aforesaid station.

The next subject which claimed the attention of the Commissioners was the duty imposed upon them by the Ordinance of the Common Council, passed the 24th of July, 1834, which requires them to specify in their report "the probable supply of water that can be obtained within the county."

The Commissioners have presumed that this provision of the Ordinance, has no allusion to the water that may be obtained by deep boring in the rock, or from the sinking of wells, as that subject was thoroughly examined by them in their report of 1833; and they have had no reason since that period, to change the opinion then formed. They have understood, however, an idea has been entertained, by some of the members of the Common Council, that a large quantity of water may be obtained from springs originating in the high lands near Harlaem and Manhattanville. It was no doubt

this opinion which, in 1826, induced the application to the Legislature, by several of our citizens, for an act of incorporation. This act was passed on the 18th of April, 1826, and is entitled "An act to incorporate the New-York and Harlaem Spring Water Company." Anson G. Phelps and James Renwick, Esquires, and their associates, are declared a body corporate for the purpose of supplying the City of New-York with pure and wholesome water. The Directors named are gentlemen of respectability and character, who would not have requested a charter, unless they intended to carry it into effect if practicable. The water was to be taken from wells near Harlaem Commons, where it was supposed abundance of the pure element existed. Experiments were accordingly made by sinking shafts, &c. but no water was found in sufficient quantity to warrant any further expense, and the company ceased to exist by *nonuser*.

In order to be satisfied for ourselves however, as to the reality of the supposition, that water was to be obtained in any considerable quantity in that part of our island, the Commissioners carefully inspected the grounds and situations alluded to, and are fully convinced, that no dependence can be placed upon the receipt of a supply of water from those sources, any more than from deep boring or the sinking of capacious wells. There was a well, under the operation of boring, near Yorkville, on the day the Commissioners made their examination. The auger had penetrated 90 feet from the surface of the earth, and no water was produced, and it was intended to descend fifty feet in addition, if found necessary. Several of the wells on Harlaem Flats were found to average from sixteen to eighteen feet in depth, and to contain from two to three feet of water. At Manhattanville, one of the wells on the slope of the public road, was forty-two feet in depth, and no water; another, three or four hundred fect below on the same road, was seventeen feet deep, and contained two feet of water. The Commissioners also examined several small springs issuing from the high hills, near Manhattanville, and one near the Hudson River, and were informed, there were several others that had disappeared,

caused, as was supposed, by the filling up of a portion of the Harlaem Canal. The Commissioners were also informed, that in excavating this canal, which sunk several feet below tide, the wells in the vicinity were deprived of water. The fact is, as the Commissioners think, that the same principle, in respect to the obtaining of fresh water, operates in every part of our island, namely, that the earth becomes so saturated, at a depth on a level with the tide of the East and North Rivers, that water will not descend lower, and in the digging of wells, where the rock does not interfere, water is uniformly found at that depth.

Any supply from the sources alluded to, therefore, would be entirely inadequate to answer all the various purposes of domestic consumption; to supply the numerous manufactories that would spring up in the northern and eastern parts of the City; the increasing number of shipping daily departing from this port; the extinguishment of fires, and the washing and cleansing of the streets and sewers of this metropolis. Nothing less than a river, distributed through thousands of channels, and brought to the premises of every householder, will be commensurate to the wants of a population, such as the City of New-York contains, and will contain.

If further evidence was required, the Commissioners might refer to the experience of other populous cities and villages, both in our own and other countries. Their example ought, surely, to have some weight with us, when making up an opinion on this subject. To suppose that they would expend millions of money to procure water from a distant source, or to raise it from their rivers by powerful machinery, when at the same time, they could obtain a sufficient supply, and as good an article, at a comparatively trifling expense, by sinking wells within the bounds of the city or village, is to suppose them destitute of common sense and prudence.

By a "report on the subject of introducing pure and wholesome water into the City of Boston, by Loammi Baldwin, Esq. Civil Engineer," it appears that a careful investigation was made of the character, quality, and uses of the water taken

from the City Wells. The whole number of wells in that City was ascertained to be 2,767. The water from 2,085 of these wells was drinkable, though brackish and hard, and 682 of them were bad and unfit for use. There was only seven of the City Wells which yielded soft water, occasionally used for washing, and from thirty-three of them the water was obtained by deep boring. "Within a few years, (says the report,) it has become common in Boston, and the vicinity, to bore for water, and to make what are called Artesian wells. But no certain or valuable result has grown out of these endeavors. I cannot find that any geological science has been acquired by any one to guide or to check those fruitless attempts; and great sums of money are idly expended every year upon mere projects founded on guess-work. There are thirty-three bored wells, only two of which are stated as furnishing soft water." With very little variation, as the Commissioners think, this description of the wells in Boston, will not inaptly apply to the situation of the public wells in this City, the most of which produce nothing but hard and brackish water, and none of which, so far as the Commissioners are informed, is sufficiently soft to authorise its use in washing clothes, &c.

On the 27th of October, 1834, the Board of Aldermen referred to the Commissioners a communication from John Hunter, in which he states that he had matured a plan, by which an abundant supply of water may be obtained, on very reasonable terms; that he proposed applying to the Legislature for a charter, and if the Common Council would consent to the application, and render such facilities for its success, as may be in their power, they may have such control over the Company as will cause a forfeiture of the charter, in the event of any neglect in fulfilling its provisions. But if the Common Council are determined to keep the project in their own hands, the plan he has to propose, is the most certain and cheapest that can be adopted, and can be commenced immediately, and put in operation in a shorter time than any other.

The Chairman of the Commissioners waited on Mr. Hunter accordingly, in order to obtain some idea of the plan he alluded

to. He declined an explanation however, but appeared willing to communicate his views to two or three of the Commissioners, in confidence. This was declined on our part, on the principle, that the Commissioners were bound to report to the Common Council, any and all the information they possessed, on the subject of supplying this City with water, and they could not therefore, receive any communication under an injunction of secresy.

On the 8th of November, Mr. Hunter in accordance with a previous arrangement, met the Commissioners at their room in the Hall of Records. That portion of the act of the Legislature, which requires the Commissioners to "make a report, containing a full statement and description of the plan adopted by them, and an estimate of the expense thereof," was read to Mr. Hunter, and he was at the same time informed, if he communicated his plan to the Commissioners, and if they adopted it, they would so report to the Common Council; if they rejected it they would so report, with their reasons for such rejection. Mr. Hunter finally promised to communicate his views to the Commissioners in writing.

On the 17th of November, a communication was received from Mr. Hunter, stating, among other observations, not material to the matter in hand, that he deemed it necessary to make his communication preliminary to a full developement at a future time; that his object in withholding his communication from the Commissioners was, that he may have some asssurance from the Common Council, that his plan will not be made use of, without his consent and approbation. He states, that he "will now develope a part of the plan, and then make a proposition to carry it into effect, not expecting it would be accepted of without a full developement, but merely to bring the subject to a tangible point." He then proposes to deliver a sufficient supply of pure water for all present purposes, "in a permanent aqueduct, of sufficient capacity, at the base of Harlaem Heights, below the surface, on the north side, ready and suitable to be elevated to the height, that it may be necessary for conveying it to the City." He further states that, he will build a reservoir of sufficient capacity, and erect the machinery for

raising the water to the reservoir, for one million seven hundred and fifty thousand dollars, the Corporation to pay all damages for land and water rights; to receive the water from the said reservoir, and to construct such other reservoirs and fixtures, for distributing the water, as they may deem necessary. The plan of Mr. Hunter, as he states, "would embrace all the water the Engineers show in their surveys and reports, or in fact all the surface or running water of the County of Westchester." "That the whole can be completed within four years from the time it is commenced, and a partial supply may be had in a shorter time, and before the whole is completed."

This is the substance of the information communicated to the Commissioners by Mr. Hunter, which, without further remark, is respectfully submitted to the Common Council, together with his communication, which accompanies this report.

In addition to the foregoing, the Commissioners have received a communication, dated the 21st of November, 1834, from Mr. Bradford Seymour, of Utica, suggesting the following plan for supplying the City with water.

Mr. Seymour proposes to erect a permanent dam in the Hudson River, extending from this City, at or near the site of the old State Prison, at the foot of Amos street, to the Jersey shore, so as to elevate the surface of the water within the said dam, from 18 to 24 inches above high tide. He estimates the expense of this erection at one million two hundred and fifty thousand dollars, and for the construction of as many ship locks as may be proper, at one hundred and forty thousand dollars each. If deemed necessary to build a lock in the centre, or channel of the river, it will add to the expense from one to two hundred thousand dollars more.

The advantages to be derived, Mr. Seymour states, will be, 1st. That the waters of the Hudson, coming from the high lands around the Sacondago and Mohawk Rivers, is the purest in the United States. 2d. That a hydraulic power, equal to thirty thousand horses may thus be obtained, twenty-seven thousand of which may be employed for manufacturing purposes, and three thousand used for elevating the water to the reservoir, for supplying the City. 3d. That by raising the water

in the river above said dam, to the height he proposes, all overslaughs and bars will be removed by the down current, and any vessel capable of entering the harbor of New-York, may proceed to Albany and Troy without obstruction. 4th. That an easy and safe communication between this City and Albany, on the ice for three months in the year may be effected. That no injury will be caused to the land on the banks of the Hudson, as the water within the dam will never be higher than it now is in high tides and freshets. Another of the advantages is, that solid and pure ice may be obtained at a small expense.

On the 29th of November, Mr. Seymour made a further communication, in which he states, that the grounds upon which be desires to de understood, is, that his estimate is predicated on the supposition, that he is at liberty to select the site of the dam, to build the coffer dam as he may desire, and the lock or locks of such dimensions as he may deem necessary for the useful navigation of the Hudson River.

That he will build the said dam, for one million five hundred thousand dollars, and the said locks for one hundred and fifty thousand dollars each, and the coffer dam for two hundred thousand dollars. If a different site from that he has named shall be selected, then he will build the dam for any price agreed upon by referees, composed of Civil Engineers; furnish the requisite security, and guarantee its durability for five years; he will require two years from the first of August next, to form the dam up to low water line; let it settle the third year, and finish the whole by the first of August, 1839.

The powers delegated to the Commissioners, and to the Common Council of this City, by the act of 2d of May, 1834, cannot extend to a project, which contemplates erecting a dam in the Hudson River, beyond the boundary line of the State of New-York. It is true, the act makes it the duty of the Commissioners, to examine and consider all matters relative to the supply of this City with pure and wholesome water; to adopt a plan, and to report it to the Common Council. If the Common Council approve the plan, it is to be submitted to the ballot box, and if concurred in by a majority of votes, the Common Council may borrow the money, and the Commissioners

may proceed to carry the plan into effect. The operation however, must be performed within this State, and under the jurisdiction of its government, and not extend into the territory of another State, as the plan for daming the Hudson evidently does. The Commissioners have not deemed it their duty therefore, to incur any expense, by engaging Engineers, to ascertain the most eligible site for a dam, reservoir, &c. or for sounding the river, or estimating the expense of erecting the dam, locks, reservoir, mill-buildings, sluices, pumps, &c. but have confined themselves to a mere outline of the plan, as proposed by Mr. Seymour, and to a brief statement of some of the difficulties to be overcome, which has appeared to them as inevitable, and which they will now proceed to designate.

1st. The great and leading object of the act of the Legislature is, to procure a plentiful supply of pure and wholesome water, for the use of the inhabitants of this City. Now, although the Commissioners have no reason to doubt, that the waters of the upper Hudson, are perfectly pure, and that by building a water tight dam across the river, from this City to the shores of New-Jersey, the salt water will be ejected, and the fresh will take its place above the dam, yet we fear, that in locking vessels up, more or less of the salt water below the dam, will follow them, and although the quantity may be comparatively small, the constant repetition of the operation, by the hundreds of vessels going through the locks, both day and night, may, perhaps, be the means of unfitting the water, in a measure at least, for domestic use.

2nd. The project cannot be carried into effect, except by an Act of the Legislature of New-Jersey, as well as by this State, and perhaps by the Congress of the United States. If all navigable rivers are common highways, it is a question at least, whether obstructions can be placed in them without interfering with the powers of Congress to regulate the Commerce of the Nation.

3rd. It must be conceded, as the Commissioners think, that the building of the proposed dam, would be an obstruction of more or less magnitude, to the navigation of the

river; for although a vessel may be locked through in 10, or 15 minutes, as asserted by Mr. Seymour, still, if we revert to the great number of vessels passing and repassing the proposed site of the dam, it can hardly be otherwise, but that there would be much detention.

4th. Not having found any data in the office of the Street Commissioner, by which to estimate the difficulties to be encountered, in building the contemplated dam, we can only refer to the known obstructions frequently experienced in sinking piers and bulkheads in both the East and North rivers, owing principally, to the large accumulation of mud at the bottom of those rivers, which often baffles the calculations and art of the builder. We have been informed too that the water, 400 feet from the shore, some distance above the site of the proposed dam, is about 30 feet in depth, and the mud at the bottom not less than 8 or 10 feet: and it is conjectured, that in the channel of the river, the water and mud is not less than 40 or 50 feet deep. The width of the river is more than a mile across, and whether a dam of sufficient solidity and strength can be erected in a river of this width, and with a current running at the rate of the Hudson, and capable of withstanding the pressure of the immense body of water that would be behind it when the tide is down, are questions the Commissioners are not prepared to answer.

5th. Mr. Seymour is of opinion, that no injury will be done to the land on the banks of the Hudson by the rise of water within the dam; but, the Commissioners think, the raising of the water permanently, two feet above its ordinary level, together with the occasional freshets which occur, must cause a covering with water, on some of the low lands laying on the margin of the river, for several miles above the city. Whether the daming the river at the place proposed, will be the means of removing the alluvial bars below Troy and Albany, or permitting vessels of a large class to proceed to Albany and Troy, without ob-

struction, as contended by Mr. Seymour, the Commissioners have no means of deciding.

6th. If the river, as low down as the proposed site for the dam, will be closed by a covering of ice for three months in the year, we should think, the cutting off so much of the navigation, would produce more injury than the privilege of proceeding to Albany on the ice, or of procuring a supply of that article for the use of those who require it, would produce benefits.

7th. The shad fishery on the Hudson, is considered of much importance to those who follow the business, as well as to those who consume the article, and we should presume, the erecting of the contemplated dam would totally destroy the fisheries, and ruin the business of those who depend on it for a living.

8th. In addition to the above, the Commissioners have obtained the opinion of Frederick Graff, Esq. the Superintendant of the water works at Fair Mount. He thinks a dam of 24 inches above high tide will not answer the purpose intended, as the space of time that the wheels could work, in pumping the water to the reservoir, would be entirely too short to insure a supply. That although the dam on the Schuylkill river, is raised six feet six inches above the highest tides, the delay in pumping, occasioned by the tides, average seven hours out of the twenty-four; and in full moon tides, from eight to nine hours. He considers the impediments to the trade on the river, by locking vessels through the dam, so objectionable, that he is induced to conclude that the project cannot be beneficial. To raise the dam higher, appears to be out of the question, as it would not only destroy all the wharf and store property of the city, above the dam, but would also destroy so much land, as to occasion the damage claims alone, a reason for abandoning the project. He thinks the advantages calculated on by the proposer of the plan,

if they could be trebled, would not compensate for the injury to the navigation of the river; and after having incurred the expense we should still be deficient in the primary object of giving to New-York a copious and wholesome supply of pure water. He is of opinion, if a bridge could be built across the Hudson, without injury to the trade of this great river, a supply of water might be obtained from the Passaic Falls; but, as that, in all probability, will not be done, it appears to him that the only safe resource to be relied on is the Croton, which may be introduced at a less expense than the proposed project of daming the Hudson. The elevated situation of the Croton will allow the artizan to make it applicable and certain to give a copious supply of water without hazard. The plan proposed, he says. could not be effected but at an expense of more than four millions of dollars. It would still be insufficient for a permanent water power. It would destroy the navigation, and it would not benefit the shoals near Albany; he is of opinion therefore, that it would do all harm and no good; it would dissipate the funds that might insure a copious supply of water from another source, and which could be relied on, provided the work shall be properly executed.

Thus much, the Commissioners have deemed it expedient to say on this important subject, leaving it to the Common Council to decide, whether the inquiry shall be further prosecuted, or whether they will adopt the plan which the Commissioners may recommend pursuant to the letter and evident intention of the Act of the Legislature, by which they have been guided in their examinations and researches, and under which, they hold their office.

The Commissioners will now proceed to state the substance of the reports made to them by the Engineers they have employed, together with a general view of the plan they have adopted, and which they have now the honor o recommending to the favorable consideration of the Com-

mon Council. It has already been stated, that the Civil Engineers employed, were David B. Douglass, John Martineau and G. W. Cartwright, Esquires, whose operations were to be entirely disconnected with each other, in the surveys, examinations, and estimates, they were directed to make. By these means, the Commissioners entertained a well founded hope, they would be enabled to arrive at a conclusion, approximating nearer to a correct result than otherwise. How far these anticipations have been realized, will be judged of by the following abridgment of the reports alluded to, and the opinion entertained by the Commissioners on the subject presented for consideration.

The following is a synopsis of the report presented by Major Douglass. Two modes are proposed for conducting the water to the city from a fountain head to be raised near Garretson's Mill, on the Croton.

1. To carry the water on a large portion of the route in an aqueduct of masonry, the top covered with wood, and the remainder of the distance by a close culvert, constructed altogether of stone or brick.

2. By a culvert or arched aqueduct of masonry for the whole distance.

The Engineer proposes raising a dam at Garretson's Mill, about five and a half miles below the location for the Muscoot Dam, as recommended by his report of 1833. The height of the dam is to be 33 feet above the bed of the river, which will give a head of water above tide of 155 feet 6 inches. The location chosen is at the narrowest part of the river below the said mill, having on the north a bold shore, and on the south solid rock as abutments of the dam. This dam will give an extent of reservoir exceeding 200 acres.

The building of a dam 14 feet in height at Muscoot Hill, with the cost of aqueduct in the form of an open canal,

about six miles to Garretson's Mill, and the damage to land and mill privileges, he estimates at the sum of - - - - - $304,750 00

The dam at Garretson's Mill will cost for its erection, together with damages to land, mills, &c.	212,800 00
Making a difference in favor of the dam at Garretson's Mill of	$ 91,950 00

The line of aqueduct, at a grade of one foot to the mile, commences at this dam, and takes the same course nearly, as that of the Hudson river route, designated in our report of 1833; varying, however, in some instances to suit a different declevity of the aqueduct. The first instance occurs at the mouth of the Croton, where it is found necessary to construct a short tunnel of about 14 chains in length, through an intervening ridge of high land. At Sing Sing, another ridge of land must be tunnelled for the length of 25 chains, in preference to taking a long and circuitous route round the face of the high lands, for the distance of the greater part of a mile.

There are some other instances where the expense is increased owing to the low graduation; but in crossing the various streams and valleys by which the line is intersected, such as Kill Brook, at Sing Sing; that of Sleepy Hollow, Jewell's Brook, the brook at Greensburg, and at other similar localities, the expense will be lessened.

In consequence of the reduction of grade, it was found inexpedient to follow the line of deep cutting by which that route was carried into the valley of the Saw Mill river. It is now proposed to enter this valley by a tunnel of seven chains, and then ascend it along the north slope, to a point favorable for crossing the river near Morrison's Mill; and by another tunnel of seven chains, to enter the valley of Tibbett's Brook, where the line strikes the route reported

in 1833, and continues down the valley, following the same system of slopes as the old line, with a graduation rather below. The grade of this line descending less rapidly than that of the former, approximates to it, and on reaching Bathgate's Plains, the ground is very favorable until it arrives at the crossing place of Harlæm river. The river is to be crossed by an aqueduct bridge of 1188 feet in length and 126 feet in height. On crossing the river, the line continues, without any material obstruction, until it arrives at Manhattanville.

The crossing of the Manhattan valley was re-examined, and re-located upon ground much more favorable than formerly. The line obtained for crossing is considered by the Engineer as fortunate, although it is still intersected by many deep and abrupt variations of surface for the last two or three miles of the route.

This portion of the route occupies generally the interval between the Eighth and Ninth Avenues, and proceeds on to the distributing reservoir, without any material obstruction.

Another line of aqueduct is designated on the map accompanying the report of the Engineer, commencing at the station for entering the valley of the Saw Mill, and crossing that river at the south of Yonkers, then proceeding down the valley of the Hudson, and crossing Spiten-Duyvel Creek, near its mouth; finally running into the line we have designated above, at about one mile above Manhattanville. The route, however, preferred by the Engineer, is the one we have followed, commencing at the dam on the Croton, and terminating at the distributing reservoir in this city.

Two locations are mentioned for distributing reservoirs. The first near Bloomingdale Square, between the Ninth and Tenth Avenues and Fifty-Sixth and Sixty-First Streets. Its distance from the City Hall on a straight line is four miles; and from the reservoir at Garretson's

Mill, by the line of the aqueduct, 39 miles 66 chains. The water will stand in this reservoir at 116 feet above tide.

The second location is on Murray's Hill, between the Fifth and Sixth Avenues, and Thirty-Eighth and Forty-Second Streets. Its distance from the City Hall is three miles, and from the reservoir at Garretson's Mill by the line of aqueduct 41 miles. The standard level of the water at this position will be 114 feet 10 inches.

These heights are considered amply sufficient for all objects required, whether for domestic or public purposes. In order to shew that the elevation of the water is sufficient, the Engineer has caused the position of some places and buildings in the city to be laid down with their height above tide. Those referred to are given in the following schedule.

Thirteenth Street, at the Reservoir,	39	feet	6	in.
Surface of the Reservoir, - - -	100	"	0	"
Washington Square, - - - - -	25	"	0	"
Roof of New University Building, -	108	"	0	"
Broadway, at the Hospital, - - -	32	"	0	"
Roof of Masonic Hall, - - - -	96	"	0	"
Chatham Square, - - - - - -	33	"	0	"
Roofs of the highest buildings adjacent,	95	"	0	"
Surface of the Park, front of City Hall,	38	"	0	"
Roof of the attic of City Hall, - -	100	"	0	"
Broadway, at the City Hotel, - -	34	"	0	"
Roof of the City Hotel, - - - -	107	"	0	"
Roof of Holt's Hotel, - - - - -	96	"	0	"

It is presumed there are no buildings in the city, at present at least, that rise higher than those designated above; and with a head of water at the distributing reservoir of 114 to 116 feet, the roof of the most lofty of them may be reached.

The estimates of the Engineer are predicated upon the presumption that the water will be conveyed in an aqueduct, on a regular and uninterrupted grade, from the fountain reservoir at Garretson's Mill to the distributing reservoir in the city of New-York.

In relation to the cost of introducing the water, several modes have been estimated by the Engineer, with a view of lessening the amount of cost. First—To commence with a slight increase of the height at the Croton dam, and from thence to Harlæm, to grade the line with a declivity of eight inches per mile, the channel way to be enlarged for the purpose. By this, a position is reached for a reservoir at Macomb's dam, 134 feet 6 inches above tide; and from this dam to lay down pipes with a head of three feet per mile, until the water is delivered at the distributing reservoir.

This plan cuts off near a mile of the distance, and avoids the two heaviest aqueducts, and several of the most expensive miles on the route. It was found, however, that the great expense of the pipes, and the additional cost of grading the channel way, would save nothing in the expense.

The items of additional cost amounted to	$1,432,939 73
Those saved amounted to - -	1,406,302 10
Difference against this plan, -	$ 26,637 63

The second trial was to lead the water into a reservoir at Macomb's dam, and thence to take it by pipes across the dam to a small effluent reservoir near the Lunatic Asylum, and from this to the distributing reservoir. The same result was experienced in this case, to a larger amount than in the former.

The items of additional cost were,	$854,014 73
Those saved amounted to, - -	788,840 35
Difference against this arrangement,	$ 65,174 38

A third plan was, to substitute inverted syphons in the place of aqueducts in crossing Harlæm river and the Manhattan valley. The estimates are founded upon the principle that the water is to be taken at a certain determined height on the Croton, and delivered at another determined height in the city, the quantity to be delivered being also assumed. Upon this data, with other collaterals, stated by the Engineer, he estimates the cost of crossing the river by aqueduct, at - - $415,650 00

That of a syphon as follows:

Three pipes of 30 inches diameter, - -	$ 63,250 00	
Bridge 880 feet long, 23 feet water, -	205,060 00	
Influent and effluent reservoirs, - -	36,000 00	
Seven tenths of an inch difference in grade per mile, - - -	66,734 50	
		371,044 50
Difference in favor of the Syphon,		$ 44,605 50

Estimate for crossing Manhattan valley,		$205,665 00
Influent and effluent reservoir, - -	$ 36,000 00	
Pipes and conduit estimated at - -	153,735 00	
Eight tenths of an inch per mile difference in grade, - -	76,268 00	
		$266,003 00
Difference in favor of an aqueduct,		$ 60,338,00

It would appear from the above, that the use of the syphon at Harlaem River, will save in the expense, $44,605 50, while a loss would be sustained at Manhattanville of $60,338, leaving a balance in favor of the aqueduct of $15,733 50.

The Engineer proceeds to discuss, at some length, the merits of the different descriptions of aqueduct or channel way for conveying the water to the City:

1st. A plain channel way or canal, without walls or covering.

2d. An open channel of masonry of some kind, as a protection against the wash of the current.

3d. An arched culvert or aqueduct, composed essentially of masonry.

For the purpose of this synopsis, however, the estimate of the Engineer for bringing the water to a distributing reservoir, at Murray's Hill and Bloomingdale square, adopting a mixed plan in one case, and an aqueduct altogether of masonry in the other, has been deemed sufficient. They are as follows:

1. For terminating at Murray's Hill, 41 miles,	$1,693,013 36
For 28 miles by aqueduct of masonry, with wood roof, ...	1,221,360 00
For 13 miles by arched aqueduct of masonry,	807,206 40
For damage to land in erecting reservoirs, &c.	335,400 00
For engineering and contingencies, &c.	372,157 97
	$4,429,137 73

2. For culvert or aqueduct of masonry throughout the whole line, terminating at Murray's Hill, ...	$1,682,593 29
For 41 miles arched aqueduct of masonry,	2,545,804 80
For damage to land erecting reservoirs, &c.	335,400 00
For engineering, contingencies, &c. .	422,839 81
	$4,986,637 90

3. For delivering the water at Bloomingdale square, by conduits, as in 1st mode, $4,132,210 33

4. For delivering the water at Bloomingdale square, by conduits, as in 2d mode, $4,689,710 49

The Engineer thinks that the works may be completed and the water distributed to the citizens in four years from the date of commencing the undertaking.

For much valuable information, the Commissioners beg leave to refer the Common Council to the able report of the Engineer.

In accordance with our instructions to Mr. Martineau, by which he was requested to ascertain the difference between the cost of erecting a high dam at Garretson's Mill, on the Croton River, and that recommended by our report of 1833, near Muscoot Hill, he proceeded to run a level and traverse from a height of 18 feet above the bed of the river at Muscoot Hill, on both sides of the Croton, when it appeared that the water would be set up two miles, 750 feet above the starting place, and would overflow 117 acres of land. The cost of the land, damage to mills, and expense of erecting the said dam, is estimated at $40,565 56.

The next object was the cost of an aqueduct for conveying the water six miles, to a station for a dam near Garretson's Mill, the aggregate amount of which, for a closed aqueduct of masonry, was $405,456 12. Total cost of Muscoot dam, including all expenses, $446,021 68.

The Engineer then proceeded to examine the feasibility of daming the Croton, at some point nearer the City than Muscoot Hill, and fixed on a location 400 feet below Garretson's Mill. In order to keep the same elevation of water as at Muscoot Hill, it was ascertained that a dam at the station selected must be raised 44 feet 9 inches above the bed of the river. The water would be backed up by this dam three fourths of a mile above the station of the Muscoot dam, and overflow 391 acres of land. The estimated amount for erecting said dam, and paying the damage for the destruction of mills, bridges, &c. was

$162,788 70. Difference in favor of dam at Garretson's Mill, $283,232 98.

Calculations were also made of the cost of an open canal of six miles in length, for conducting the water from the dam at Muscoot Hill, to the location below Garretson's Mill, instead of using a closed aqueduct of masonry, as in the foregoing estimate, which resulted as follows:

The amount of all the items put together, including damage to land, mills, &c. was $229,004 54. The building of the dam at Garretson's Mill, as above, was $162,788 70.

Difference upon this principle in favor of Garretson's Mill, $66,215 84.

A line was then traced from this dam to a location for a distributing reservoir on Murray's Hill, in the City of New-York, and the separate items involved in the execution of the whole work of erecting the dam, constructing the aqueduct on a grade of 15 inches to the mile, building reservoirs, paying damages, &c. was collected and classified, which resulted in the aggregate of $4,232,814 85.

The Engineer next proceeded to ascertain whether a dam might not be raised, with advantage, at a location near the mouth of the Croton, and proceedings were accordingly commenced for examining the feasibility of throwing a dam across the river, at or near tide water, so as to raise a fountain of 150 feet of elevation above tide, and thus approach five miles nearer the City. A site was selected about 20 feet above tide, near Halman's Mill, and it resulted that the water of the river would be backed up one mile and four hundred feet above Garretson's Mill before it would fall within its banks, or six miles above the location of the dam. More land would be flooded, but of much less value than by a dam at Garretson's Mill. The value of the land that would be thus overflowed, injury to mills and mill privileges, damage to houses, rebuilding bridges, and constructing a permanent dam at the aforesaid station, is estimated at the sum of $275,200.

From the dam at Halman's Mill, a line was commenced and carried towards the City at a grade of one foot to the mile.

On leaving the Croton Valley, several ravines and ridges are encountered, which will require embankments of considerable heighth, and deep cuts of more or less depth. The line passes the villages of Sing Sing, Sparta, and Tarrytown, occasionally meeting with ridges of high land, to be excavated or tunnelled, and valleys and ravines, to be crossed by embankments, until it arrives at Dobb's Ferry. No difficulty is met with from this point, until encountering the dividing ridge between the Hudson and Saw Mill Rivers. This is the most formidable obstacle on the whole line. The greatest elevation is sixty feet, and for more than half a mile, of thirty feet ; the whole length of this deep cut is three fourths of a mile. In the estimate, 2500 feet is computed to be tunnelled. Saw Mill Valley next occurs. Its breadth is 700 feet, and the surface of the river 24 feet above the line of aqueduct. This must be passed by an embankment, and a large culvert of 16 feet span. The line having gained the western slope of the high land east of Saw Mill River, continues over favorable ground, until it arrives four miles distant, and nearly opposite Yonkers, where a depression in the ridge occurs at Tibbett's Brook, through which the line passes, following the road into the valley of the brook, which it is proposed to cross by a dam, forming at this place a capacious storing reservoir, if desirable. From this the line is conducted towards Harlaem River, over favorable and unfavorable ground, until it reaches the proposed place for crossing the river, a short distance north of Devoe's house, and about three fourths of a mile north of Macomb's dam. The crossing place is 1320 feet wide ; the surface of the river 600 feet, skirted by a strip of bottom land on the north, 260 feet wide, and 25 feet above high tide. Having gained New-York Island, the line proceeds along a steep, broken, rocky-side hill, for a short distance. Leaving this, it attains a more fair surface, until it reaches the ridge north of Manhattanville, where the ground is favorable for a large reservoir. Here it is proposed to terminate the line of aqeduct. From this point the proposition is to pass Manhattan Valley, by an inverted syphon of iron pipes of large calibre. At the south

side of Manhattan Valley, the surface is very undulating and gradually declining, until the line terminates on a smooth elevation between the 5th and 6th Avenues, at 38th street, a position well adapted for the location of a distributing reservoir. Between the receiving reservoir, and that proposed at 38th street, as a distributing reservoir, no other is deemed necessary at present; the more especially if the iron pipe connecting the the two be of the capacity recommended, namely, six feet diameter. This large pipe will render it unnecessary to have the distributing reservoir more than half the size recommended by D. B. Douglass, Esq.

DISTANCES.

1. From Garretson's Mill to leaving the Croton Valley,	5 miles
Croton Valley to Manhattanville, . .	$30\frac{1}{2}$
Manhattanville to distributing reservoir, .	$5\frac{1}{2}$
Total, . . .	41 miles
2. From Halman's Mill, near tide water, to Manhattanville, ...	$30\frac{1}{2}$ miles.
From Manhattanville to distributing reservoir,	$5\frac{1}{2}$
Total, ...	36 miles.
3. From Muscoot Dam to distributing reservoir,	47 miles.

The quantity of deep cutting on the whole line is estimated at 10,090 feet, about 3,000 of which it is proposed to tunnel, and the residue to be cut as an open canal to receive a channel way of masonry, except where there is rock, which it is intended shall constitute the channel. The average breadth of the ravines to be passed is about 9,500 feet, which it is proposed to cross by embankments formed of rock and earth, employing for that purpose, the rough excavated rock for the interior, as far as it will go, and good quality stone to be used for the outside slope wall of the embankment.

The ridge intervening between the Hudson River and the Saw Mill Valley, is by far the heaviest point of excavation that occurs, and is estimated at 115,000 cubic yards, a part of which may be tunnelled.

There will be numerous culverts required, but none of large dimensions. The largest is that passing Saw Mill River, of 16 feet span; nor are there any large arches, except that crossing Harlaem River.

For crossing Harlaem River two plans are suggested. First, by a suspension aqueduct formed by wire cables, supported by pillars at wide intervals, the ends of the cables being well secured on either shore, supporting a channel way of wood or iron. This would be less costly than that of high arches thrown over the river, but greater than the following plan.

Second. The plan recommended is a massive embankment, composed in great part of rough stone, at a slope below the water of one and a half feet to one, or on an angle of 34 degrees. Above low water mark the exterior stone work is intended to be laid in a heavy compact stone wall, carried up at an angle of 45 degrees, to about 30 feet above tide, having an arch of 60 feet span (to keep open the navigation and allow the passage of the tide) springing from the surface of the water, from substantial abutments, which with the arch and spandrel walls is proposed to be formed of the best hydraulic masonry. The arch is to be semi-eliptical in form, and the breadth of embankment. 30 feet on the top. On this bridge the water is to be conveyed across the river by a large iron pipe formed of wrought iron half an inch thick and eight feet in diameter.

If the water shall be taken from Garretson's Mill, at a descent of 15 inches to the mile, an aqueduct of eight and a half feet in diameter will be sufficient. But if taken from Halman's Mill, near the mouth of the Croton, with a descent of one foot to the mile, the calculation at this grade is for an aqueduct of nine feet in diameter. This will carry, when running nearly full, the whole minimum flow of the Croton

during summer. If the line was perfectly straight, it would deliver 60 millions of gallons in 24 hours; but on account of the sinuous course the channel must take, one third of this quantity may be deducted, and 40 millions taken as the quantity such an aqueduct is capable of delivering into the distributing reservoir every 24 hours.

The aqueducts are intended to be cylindrical or round in form, composed of masonry, fourteen inches thick, with stone of good quality, and well grouted with hydraulic cement. There are on the whole line of the work, quarries of good building stone, easily procured, affording abundance of material for constructing the necessary aqueducts and other erections.

The communication between the receiving reservoir at Manhattanville, and the distributing reservoir at 38th street, (about five and a half miles,) is computed to be by iron pipes, six feet in diameter, and three quarters of an inch thick, to be buried at a proper depth, to conform to the regulated grades of the City streets, that have or may be fixed on.

The following estimate applies to the line from Halman's Mill, near the mouth of the Croton, which gives one foot descent to each mile, through an aqueduct of nine feet diameter, and will deliver the whole of the water of the Croton, if required, at the distributing reservoir near 38th street, 114 feet above high tide.

The whole amount of excavation from the dam near Halman's Mill, to the receiving reservoir at Manhattanville, exclusive of deep cuts, separately computed, is 451,250 cubic yards, at thirty cents, ...	$135,375 00
One-fifth supposed to be rock, 90,250 cubic yards, at $1 40, ...	126,350 00
Deep cuts, exclusive of tunnels, 78,657 cubic yards, at fifty cents, ...	39,328 50
One-fourth of this supposed to be rock, 19,664 cubic yards, at $1 50, ...	29,496 00

3000 lineal feet of tunnel, supposed to be cut through rock, at $25 per foot, running measure, ...		75,000 00
3250 feet excavated through earth at $5, .		16,250 00
Embankments across valleys and ravines, supposed to be supplied in part from the earth excavated, 263,850 cubic yards at 30 cents,		79,155 00
Slope wall outside of banks, 92,802 cubic yards, at 75 cents, ...		69,601 50
Culverts and weirs on the whole line, . .		81,000 00
Total for excavations, &c. . .		$651,556 00
Harlaem River embankment, rough stone and slope wall, together 53,275 cubic yards, at 75 cents,	39,956 25	
Embankment of the upper part with gravel, 61,217 cubic yards, at 37½ cents, ...	22,956 37	
Arch of 60 feet span, including coffer dam, &c.	62,325 00	
Iron pipe, 8 feet diameter, of wrought iron, ...	62,500 00	
Total cost of crossing Harlaem River, .		$187,737 62
Twenty-seven miles aqueduct of masonry, nine feet diameter, walls 14 inches thick, $47,142 per mile, ...		1,272,834 00
Dam at Halman's Mill, 150 feet in height, .		269,610 00
Five and a half miles of iron pipe, six feet diameter and ¾ of an inch thick, at $175,000 per mile, ...		962,500 00
Reservoirs, ...		175,000 00
Damage and cost of land on the line, . .		25,000 00
Damage to water rights, &c. estimated at .		50,000 00
Add for contingencies twelve and a half per cent.		452,521 12
Total cost of dam, aqueduct, &c. from mouth of Croton, ...		$4,046,758 74

The total cost of dam, aqueduct, &c. from Garretson's Mill, estimated on the same principle, is $4,232,814 85

Thus it appears that the line from Halman's, near the mouth of the Croton, can be constructed for $186,056 11 less than that from Garretson's Mill.

Mr. Martineau states, that he had collected data for estimating the cost of bringing the water in an open canal, formed of the natural soil of the country through which it passed; and also, at the request of the Commissioners, for ascertaining the cost of an aqueduct of stone with upright walls, laid dry or in cement, with an eliptic bottom, and covered on the top with board or shingle roof. The open canal the Commissioners cannot recommend, for the reasons given in another part of this report, and others, which might be added, if deemed necessary. The difference in the cost of constructing an aqueduct of square stone work, with a wooden cover, and that of a round or cylinder form, is so small, in the opinion of the Engineer, that it is not an object worth attention. The excavations, embankments, reservoirs, iron pipes, damage to land, mills, dwellings, and water rights, must be the same in either case, and the work, when completed, would lack that permanence of finish which ought to constitute a project of this magnitude and importance.

The Engineer also states, that in view of all the details of construction, an open canal, without masonry or covering of any sort, could not be executed for less than two thirds of the amount of the foregoing estimates, say about $2,800,000. If any other plan than that recommended be adopted, with a view of reducing the cost, he is of opinion, that the most suitable for the purpose, would be an open canal, walled up on the sides with dry masonry; the bottom semi-eliptical, the depth three-fourths of the width of channel way; the whole course would require to be puddled before laying the walls. Such a canal, it is believed, could be completed for about one-fourth less than the amount of estimate for a covered tunnel of masonry, say $3,100,000.

By the report of George W. Cartwright, Esquire, it appears he run two levels from a position near Garretson's Mill, on the Croton, one at 38 feet, and the other at 40 feet above the bed of the river, at the aforesaid place, and carried them up until they lost themselves at the surface of the water. In accordance with his estimate, the building of a dam of 32 feet in height, will make a pond of water covering 180 acres, and will damage property to the amount of $21,000; and by raising the dam to the height of 40 feet, the pond will cover 350 acres, and the damage will amount to $41,300.

Mr. Cartwright also made a gauge of the river on the 9th and 14th of October, 1834. At the first period, he calculates the flow per diem at 97,771,810 gallons, and at the second period, at 92,532,408 gallons; from which deduct one fifth for times of drought, the flow will be reduced to 74,025,927 gallons, which is much greater than that estimated either by Major Douglass or Mr. Stein.

The Commissioners are informed by Major Douglass, that he was put in possession of the measurement and gauge of the Croton by Mr. Cartwright, and that he can only make the flow to be rising 51,000,000 of gallons every twenty-four hours. He is satisfied, therefore, that Mr. Cartwright must have made some mistake in his calculations.

An opportunity was also embraced by Mr. Cartwright, shortly after the intense frost in the early part of January last, to examine the effect of the weather, touching the freezing of the river. He chose for that purpose a canal, constructed more than forty years ago, for conveying the water to a site for a mill. This canal was about 10 feet in width. He found the ice on the top to average about 12 inches in thickness, three or four of which was from snow, with three feet of water under it. The velocity of the current he estimated to be near 200 feet per minute. From this data he concludes that a canal or aqueduct sunk in the ground, open at top, with a depth of 5 or 6 feet of water, and a velocity of 70 or 80 feet per minute, will never freeze to exceed 12 or 14 inches in thickness. He suggests, therefore, the propriety of conducting the water

through a channel way, walled with dry stone on the sides, and lined or puddled on the bottom with clay, to be 6 feet at bottom, 10 feet at top, and 8 feet in depth. The side walls 3 feet thick at bottom, and 1½ feet at top, with a fall varying from 8 to 16 inches per mile, and giving an increase of declivity, at the curves of the line, to meet unavoidable obstructions to the flow of the water. Such an aqueduct, he thinks, would deliver 15 or 20 millions of gallons per day.

In point of expense, Mr. Cartwright is of opinion it would be less in the cost about one and a half millions, than the splendid work recommended by Major Douglass, while it would leave all the other parts the same as his, except the channel way.

The Commissioners have been favored with some valuable information by Albert Stein, Esq. a gentleman highly recommended as a Civil Engineer. In the month of September last, he accompanied the Commissioners on a tour up the Croton River, and on the 25th of that month made a gauge of its waters. The quantity flowing on that day, in accordance with accurate measurement, made at equal distances from each other, near Pine's Bridge, and about three miles higher up the river, near Wood's Bridge, were as follows:

Section 1.	57,101,068
Section 2.	49,971,686
Section 3.	49,276,080
Section 4.	47,959,344
Total,	204,308,178

Averaging 51,077,044 gallons every twenty-four hours.

The river was gauged by Major Douglass on the 5th of September, 1833, at Wood's Bridge, and the produce on that day was 51,522,480 gallons every twenty-four hours, making a difference between the two gauges of only a few hundred gallons. Mr. Stein, from information obtained on the spot, was induced to deduct four inches from the surface of the river,

to meet extraordinary droughts, which reduced the quantity as follows :

Section 1.	28,731,715	gallons.
Section 2.	23,186,908	gallons.
Section 3.	33,004,800	gallons.
Section 4.	32,707,066	gallons.
Total,	117,630,489	gallons.

Averaging 29,407,622 gallons every twenty-four hours.

From the information received by Major Douglass, communicated by persons residing in the vicinity of the river, and who had frequently observed its changes, from high to low water mark, he deemed it necessary, with the same object as Mr. Stein, to deduct one fifth of its whole daily flow, and thus reduce the number of gallons per diem to 44,120,924. There can hardly be a doubt, however, in the opinion of the Commissioners, that the quantity of running water which may be depended on at all seasons, will never be less than thirty millions of gallons per day.

Mr. Stein has also furnished an estimate of the probable cost of two or three different kinds of aqueduct, and an estimate of the quantity of water they will deliver at the end of the line, with a head of 40 feet, and a descent of 15 inches to the mile.

He observes, that "the greater the circumference on the sum of bottom and two sides touched by the water, the slower will be the velocity in the canal." This is also one of the principal causes of the decrease of the velocity in rivers at low water mark, and that by an equal fall the shallow rivers flow slower than the deep ones.

"The circle presents the best surface, and is therefore the most suitable for the conveyance of water, and the nearer we come to half a circle in the formation in the cross section, the less resistance will the water meet with in its motion."

The next form of aqueduct proposed by Mr. Stein, as best calculated for the purpose of conveying water for domestic use, is a canal with side walls of masonry. For a canal of

this description, with a depth of water of 6 feet, and a fall of one foot to the mile, he makes the following estimate:

The side walls are estimated at 222,657 cubic feet per mile, at 18 bricks to the foot, will require 4,007,837 bricks, at $10 per thousand, will amount to . . . $40,078 37

32,560 cubic yards of excavation, at 25 cents per. yard, ... 8,140 00

Cost per mile, ... $48,218 37

According to this estimate, a canal of forty-one miles, at $48,218 37, would amount to $1,928,734.

Mr. Stein's estimate for excavation, is far less than it would have been, had he possessed a proper knowledge of the ground to be excavated. Instead of this, the only knowledge he could possess, was derived from a view of the surface of the country, while travelling over it in a carriage. He has no doubt, therefore, made his estimate, on the presumption that the line to be excavated, was a plain of regular feature, without rocks, high ridges, or deep ravines and valleys, to be excavated and crossed.

The Commissioners have also been furnished by this gentleman, with the cost of laying iron pipes, and the quantity of water they will deliver every 24 hours, with a head of 40 and 50 feet at the fountain.

A pipe of 30 inches diameter, laid perfectly straight, with a head of forty feet, and a uniform slope of one foot per mile, will discharge two million nine hundred and twenty-three thousand six hundred and eighty-nine gallons every twenty-four hours; and a pipe of the same dimensions, with a head of 50 feet, will deliver three million two hundred and forty-eight thousand four hundred and sixty-seven gallons per day. Taking the running foot of 30 inch pipes at thirteen dollars and twenty-five cents, laid complete, the cost of a single line of forty miles, would amount to two million seven hundred and ninty-six thousand four hundred dollars. If allowance be made, however, for the sinuosity of the pipes, on the line from the Croton to this City, the quantity of water discharged at the

point of delivery, would be much reduced, and at least four or five lines of 30 inch pipes would be required, at a cost of from eleven to twelve millions of dollars.

This mode of bringing the water to the City, therefore, is entirely out of the question.

We have now given a slight view of the principal heads of information, derived from the reports of the Engineers, and must refer your Honorable body to the said reports, for the several items, comprising the various aggregates, and the reasons in favor of the results arrived at by the gentlemen alluded to.

Before commencing an examination, preparatory to deciding on a plan, which the Commissioners intend recommending, for supplying the City of New-York with good and wholesome water, it may be proper to observe, that the estimates of the Engineers, in every case, are assumed to be correct; and that the aggregates of expense under each head is amply sufficient to insure the completion of the work for the sums stated; and we are the more confident in this, because our instructions to these gentlemen, were, to state the full amount of cost in every instance, in order that the actual expenditure may rather fall short of the estimate than exceed it.

We proceed to state the estimated amounts of each Engineer on particular parts of the work, and the reasons, as far as the Commissioners can perceive them, for any discrepancy which may appear.

Amount of damage to land, &c. by erecting a dam at Garretson's Mill.

Estimated by D. B. Douglass, dam 33 feet high, cost	$28,500
" by G. W. Cartwright, dam 40 ft. high, cost	41,300
" by John Martineau, dam 44 feet 9 in. high, cost	93,614

The difference in the height assumed by the Engineers, is no doubt the main cause of difference in the amount of cost, as stated above.

The building a dam at Muscoot Hill, including damage to land, mill privileges, and cost of aqueduct to Garretson's Mill:

Estimated by D. B. Douglass to amount to,	$304,750
" by John Martineau, . . .	229,004
Difference, ...	$75,746

Building a dam at Garretson's Mill, including every expense.

Estimated by J. Martineau at	$69,174, 70
" by D. B. Douglass, at . .	33,617, 00
Difference, . .	$35,557, 70

This difference may be accounted for, by the difference in the heighth of the respective dams, Mr. Martineau assuming 44 ft. 9 in. as necessary, while Major Douglass takes but 33 feet.

Cost of dam at Halman's Mill, compared with that proposed at Garretson's Mill.

Total cost estimated by J. Martineau, .		$269,610
Cost of dam at Garretson's mill, as estimated by D. B. Douglass,	$33,617	
Five miles of aqueduct from Garretson's Mill to Halman's Mill at $47,142 per mile, ...	235,372	269,327
Difference. . . .		$283

It would appear, from the foregoing result, that in point of cost, there is nothing worth noticing to be saved between erecting the dam at Halman's and Garretson's. It however leaves us five miles of aqueduct less to be cared for, and it may be of some advantage, in relation to the mill sites, and the quality of land overflowed, which, it is stated, is of a much worse character than that to be overflowed by the dam at Garretson's Mill.

The difference in the height of the dam proposed to be built by D. B. Douglass, at Garretson's Mill, and by J. Martineau, at Halman's Mill.

By D. B. Douglass, at Garretson's Mill,	33 ft
J. Martineau, at Halman's Mill,	150 ft.
Difference. . . .	117 ft.

The descent of the river for 5 miles, is at the rate of 25 feet per mile,	125 ft.	
Descent of aqueduct 15 inches, each mile deducted, . . .	6 3	118–9
Dam at Garretson's exceeds that of Halman's above tide, ...		1–9

Crossing Harlaem River by aqueduct, and by wrought iron pipe, or inverted syphon, as to cost.

Estimated by J. Martineau, for wrought iron pipe, ...	$187,737 62
" by D. B. Douglass, by high arches and aqueduct, ...	415,650 00
Difference in favor of an inverted syphon,	$227,912 38

It has been objected to this description of pipe, that wrought iron is more subject to corroding with rust than cast iron. There could be no corroding from the interior, however, as the running water would prevent it; and it is presumed some method might be adopted, by casing the pipe with wood, or some other material as a preventive, if found necessary. At any rate, a pipe of this description, half or three quarters of an inch in thickness, would require many years before it would be destroyed with rust. The difference in the cost of crossing the river by a pipe of thc description alluded to, compared with that of an aqueduct, is so considerable, that, in the opinion of the Commissioners, it ought to be adopted, unless there

should appear more serious objections to the plan than any they have as yet heard. It appears by the report from Major Douglass, that crossing the river with pipes is much cheaper than by that of an aqueduct. He states that the expense of four 30 inch iron pipes, erecting a bridge to lay them on, and building an effluent and influent reservoir, will cost $364,280, while the high arched bridge and aqueduct will cost $415,650. Balance in favor of iron pipes, $51,370.

It may be a question to be considered, whether this mode of crossing the river may not be the best for the present—the number of pipes to be increased as the wants of the City may require it. There would be this advantage in the plan: if any of the pipes failed, or required repair, there would be no obstruction to the flow of the water, in the meantime, through those remaining in good order; while, with a single pipe or aqueduct, something of the kind alluded to might occur.

The crossing Manhattan Valley, and on to the distributing reservoir at Murray's Hill.

Estimate of J. Martineau, for cost of receiving reservoir on the north of Manhattanville, .		$43,750
5½ miles of pipe, 6 feet diameter, at $175,000 per mile, ...		965,500
		$1,008,250
Estimated by D. B. Douglass, as the cost of the Manhattan aqueduct,	$505,665	
Five miles of closed aqueduct, at $62,029 80 per mile, . .	310,464	516,129
Difference in favor of aqueduct, . . .		$490,121

The Commissioners have endeavored to ascertain whether the pipes of six feet diameter have ever been, or can be cast by the furnaces in this country, and the cost at which they might be obtained. From information they have received from T. S. Richards, J. Elliot & Sons, and W. Kemble, on this subject, there appears much doubt whether they can be

cast at all, except at a much greater expense than the ordinary sizes, and much thicker than that proposed. The great difference, however, between the amount estimated for crossing the valley by these pipes, and that of crossing by aqueduct, is sufficient, in the opinion of the Commissioners, to induce an abandonment of the measure.

The height of water in the distributiug reservoir.

By the grade proposed by D. B. Douglass,	114 ft. 10 in.
By the grade proposed by J. Martineau. .	114 ft.
Difference, ...	10 in.

Cost of a close aqueduct of masonry.

Estimated by Albert Stein, to be altogether of brick, per mile, ...	$64,999 38
Estimated by D. B. Douglass, part stone and part brick, per mile, ...	62,092 80
Estimated by J. Martineau, altogether of stone, per mile, ...	47,142 00

It appears, therefore, that an aqueduct composed of stone altogether, is much the cheapest construction.

ESTIMATE OF THE WHOLE ROUTE.

By J. Martineau, from Garretson's Mill to Murray's Hill, 41 miles by closed aqueduct,	$4,232,814 85	
Deduct savings in expense in crossing Manhattan Valley,	490,121 00	—$3,742,693 85
By D. B. Douglass, by closed aqueduct 41 miles to Murray's Hill, . . .	4,986,637 90	
Deduct savings in crossing Harlaem River, by inverted syphon, ...	227,912 32	—4,758,725 58
Difference in favor of Martineau, . .		$1,016,031 73

Estimate of J. Martineau, for closed cylindric aqueduct from dam at Halman's Mill, thirty-six miles, . .	$4,046,758 74	
Deduct savings in crossing Manhattan Valley, . .	491,122 00	3,555,636 74
Estimate of D. B. Douglass, for closed aqueduct from Garretson's Mill, 41 miles to Murray's Hill, . . .	4,986,637 90	
Deduct savings by crossing Harlaem River by an inverted syphon, instead of aqueduct,	227,912 38	4,758,725 52
Difference, . . .		$1,203,088 78

The difference in these estimates no doubt arises mainly from the manner proposed for constructing the aqueduct; that by Major Douglass being composed partly of brick, will cost more by $612,982 80, than if constructed altogether of stone, as proposed by Mr. Martineau.

The Commissioners have been furnished by Uzziah Wenman, Esquire, City Water Purveyor, with a map, designating the line of pipes that will be necessary, in addition to those already laid by the Corporation, and the cost that will accordingly accrue. The total sum to be added to the estimates of the Engineers, for leading the water from the distributing reservoir at Murray's Hill, through the different streets of the City, in accordance with Mr. Wenman's estimate, will amount to $1,261,627. The report of Mr. Wenman is herewith submitted.

PLAN OF INTRODUCING THE WATER.

Whether the water be taken from the site for a dam near Garretson's Mill, or from that near Halman's Mill, can make

no difference in the cost, as has been shown by the comparison we have drawn between the cost of the two structures—the difference being only $282. No inconvenience can be experienced, therefore, by leaving this question for future examination and decision. For the present purpose, however, the Commissioners will assume the position at Halman's Mill, and accordingly propose that a dam of sufficient elevation be erected near the mouth of the Croton River, and from thence the water to be conducted in a close stone aqueduct to Harlaem River. The river to be crossed by inverted syphons of wrought iron pipes of 8 feet diameter, formed in the manner that steam boilers are. From the south side of the river, a line of stone aqueduct will again commence, and proceed across Manhattan Valley to the distributing reservoir at Murray's Hill.

The whole work as appears from the estimates of D. B. Douglass, Esq. after deducting the saving in crossing Harlaem River by syphon, instead of aqueduct, will cost	$4,758,725 58
The estimate of John Mortineau, Esq. after deducting the saving in crossing Manhattan Valley by aqueduct, instead of syphon, being for the same line as the above, is	3,742,693 85
Total of the two estimates, . .	$8,501,419 43
Average of the two estimates, . .	$4,250,709 71
The Commissioners think it fair to assume the average of the two estimates as the true sum, say . .	$4,250,709 71
To which add the cost of City mains and conduits, ...	1,261,627 01
Total cost of introducing the Croton water,	$5,512,336 72

A very important duty remains to be performed, viz: to report an estimate of the probable amount of revenue that will accrue to the City, upon the completion of the works, and

the reasons and calculations upon which our opinion and estimates may be founded.

The amount of revenue must depend, in a great measure, upon the plan which may be adopted for assessing and collecting it. Various plans have been suggested. First, to charge a certain per centage upon the amount, for which the premises supplied with water would rent. Upon this principle, take the assessed value of the real estate in this City, which for 1834, is valued at $123,256,480. By stating it at one hundred millions, omitting the $23,256,480, for property from which no revenue is derived, and supposing the rents receivable to amount, on an average, to ten per centum, the total income would be ten millions of dollars. Now, three per cent on this sum would bring $300,000, which would be more than sufficient to pay the interest on the capital expended, and for annual attendance on the operation of the works. Thus, a house renting for $300, would only pay nine dollars annually, for which the inmates would receive a full supply of pure and wholesome water, not only for drink and culinary purposes, but for bathing, washing of clothes, streets, yards, &c.

Another suggestion takes the population at 300,000; and allowing six persons to a family, the conclusion is arrived at, that the population is equal to fifty thousand families, and in case each of them paid six dollars annually for a supply of water, it would amount to $300,000, by which the same result is arrived at as the first named project.

The plan most generally adopted, however, for raising a revenue is by a tariff of rates, proportioning the charge in accordance with the probable quantity of water used. The Manhattan Company apportion their charge in accordance with the number of fire places in the dwellings supplied with their water. Thus, small houses, containing from one to three fire places pay five dollars per annum, while houses of the largest class pay fifteen dollars; the average of this charge for dwellings is $9 63, if occupied by one family; and for more than one family, three dollars each in addition. For grocery stores, ten dollars each; for bake houses, ten dollars

for each oven. Factories, buildings, boarding houses, taverns, distilleries, breweries, dye houses, &c. according to agreement. The laying and repairing of the lateral pipes is done at the expense of those receiving the water, and the rates are to be paid half yearly in advance.

About one thousand families, in Boston, are supplied with water by the Boston Aqueduct Company, at an annual charge of from ten to twelve dollars to each family.

The Providence Aqueduct Company, State of Rhode Island, charge ten dollars per annum for a family of six persons; and a right to be supplied with water from their fountain may be purchased for $125 cash, and by paying a due proportion annually of the expense of keeping the main pipes and fountain in repair.

The City of Albany is partially supplied with water by a chartered company. The water is procured from a creek between two and three miles north of the City, and brought to the distributing reservoir through a line of six inch iron pipe. About 1200 dwelling houses are supplied from this source, and the rates charged for the use of the water are as follows:

A three story house, per year, ...	16 00
Three stories, one room deep, with back building,	14 00
One and a half story front house, ...	14 00
Ordinary three story houses, ...	12 00
Double two story house, ...	12 00
Single two story house, with dormer windows, .	8 00
One story house, ...	6 00
Stores where the water is used only for drink, .	4 00

The above rates are for a single family only; for every additional family in a house, three dollars for each, and a further charge of two dollars for every family more than two. Boarding houses, and hotels pay from sixteen to sixty dollars. Brewers pay fifty dollars per year, and two cents per barrel in addition for every barrel of beer brewed over one thousand.

Malt houses pay forty dollars for the first five thousand bushels malted, and five dollars for every additional thousand bushels.

Since 1820, the company have divided to their stockholders from six to seven and a half per cent per annum, and their regular dividends may now be safely estimated at seven per cent per annum. For the above information the Commissioners are indebted to the politeness of the Hon. M. Van Schaick.

The Commissioners have been furnished by the Hon. George Tibbets, Mayor of the City of Troy, with a detailed account of the water works nearly completed at that place. Troy has advantages, in this respect, not possessed by New-York. The water of the Hudson, by which the City is bounded on the west, is of the best quality, and there are besides a number of streams having their source in the highlands to the east of the City, whose waters are perfectly soft and pure; and the capacity of which is equal to the wants of the present, and perhaps the future population of the place. The stream selected for the purpose of supplying the citizens with water, is the *Piskawin creek*, and the distributing reservoir is placed on its margin about one third of a mile east of the City, and at an elevation of one hundred feet above tide, and about seventy-three feet above the plain upon which most of the City buildings are erected. The reservoir will hold about 1,900,000 gallons, and the minimum supply of the creek at an unusually dry time, was 840,000 gallons per diem, which will allow 56 gallons per day to each soul, estimating the population at 15,000.

The main, which first receives the water, is sixteen inches diameter where it enters the reservoir, tapering down to twelve inches at the other end. The mains running through the several streets, vary from twelve to three inches diameter, according to circumstances. It has been ascertained at Troy, that a 12 inch main, with a head of 73 feet, will discharge from the reservoir and deliver into the City 1,500,000 gallons, every twenty-four hours.

The whole cost of the Troy Water Works, viz. for the purchase of land and water rights, building the reservoir, and laying the main pipes through the City, will amount to about $115,000. The annual expense of attending the works, is but $800; five hundred to a Supeintendent, and three hundred to a Clerk.

The rates at which the water is furnished, are as follows: for a single family, who pay for laying the lateral pipes, $5 50 per annum. If the expense of laying the lateral pipes is paid by the Corporation, $6 50 per annum. For hotels, from 15 to 60 dollars each; Breweries, $50; Livery Stables, $15; Distilleries, $50; Tanneries, $20; Dyers, $15. Manufactories using a steam engine, from 20 to 40 dollars per annum. For water used by masons in the erection of new buildings, five cents per thousand for all the bricks worked up, and five cents for every hundred feet of stone wall.

These rates are uncommonly low, and are warranted by the great facilities for obtaining the water, and the moderate cost of the works.

It reflects much credit on the municipal authorities of Troy, that they have thus preserved to the inhabitants, a control over the supply of this necessary and indispensable article of consumption, at a moment too, when it was about being wrested from them by a chartered company. It appears, an act was passed in 1829, incorporating a company for supplying the City of Troy with good water, delegating to it all the necessary powers and privileges for carrying the same into effect. The Common Council of Troy, however, aware of the evils experienced from joint stock companies in other cities where they exist, obtained an Act of the Legislature in 1832, authorizing the Troy Water Works Company to convey to the Corporation of the City all their rights, title and interest held under their charter; and, at the same time, investing the Corporation with the necessary power for acquiring the requisite land and water rights; raising such sum of money, by loan, as might be required, and authorising the passage of such ordinances relative to the introduction, distribution and use of the water, as they might

deem necessary and useful. The company for bringing in the water, therefore, consists, as it ought, of all the citizens of Troy, and each individual, through their representatives in the Common Council, has now a voice and interest in the measure, of which they would have been forever deprived, under a private corporation.

It appears then, that the average rate charged by the Manhattan Company of this City, is . .	$ 9 63
By the Boston Aqueduct Company, . . .	12 00
By the Providence Aqueduct Company, . .	10 00
By the Albany Water Works Company, . .	11 07
By the Corporation of Troy, . . .	6 50
By the Corporation of Philadelphia, (see page .)	6 00
	$55 20

Making a general average of $9 20. Thus we are enabled to ascertain the average charge for water supplied a single family, by six of the companies established in different parts of the United States. The rate demanded of other water takers, appears to be regulated by the probable quantity of water used, and can, therefore, only be estimated by conjecture, when, as in the present case, there is no positive or certain data to build upon.

The Commissioners have been at great pains to collect from the various sources in our own country and abroad, information on the operation of supplying water by artificial means, in order that they might the better perform the duties required of them ; but they are compelled to confess, that the knowledge they have acquired is by no means so satisfactory and full as they could wish, or had a right to expect ; owing, in part, to the few publications on the subject, and the brief and general manner in which it has been treated by such as have appeared in print ; and, perhaps, to the fact that most of the water companies are private incorporations, whose objects are better answered by an increase of dividend to their stockholders, than by benefitting the public, or disseminating useful information relative to the conducting of their affairs.

The Commissioners have been enabled to glean some general information as to the rates charged, and the income received by the London Water Works Companies, derived from extracts of a "Report of the Commissioners appointed to inquire into the state of the supply of water in the metropolis," made on the 21st of April, 1828. This inquiry was instituted by order of the British Government, in consequence of a very general complaint of the impurity of the water drawn from the river Thames, and in some instances, of the limited supply.

The following table has been compiled from such portions of the report alluded to, as appear in "An Historical Account of Sub-ways," printed, London, 1828; and in a "Treatise on the Police and Crimes of the Metropolis," printed, London, 1829.

NAMES OF COMPANIES.	Daily supply in gallons by each Company.	Number of houses supplied by each Company.	Quantity supplied daily to each house.	Average rate charged per year.	Capital employed by each Company.	Annual income of Companies north of the Thames.	Per cent. earned on the capital.	Annual expenditure	Annual nett profit.
New River,	13,000,000	67,000	19[illegible]	$6 22	$4,616,555	$425,142	9 pr. ct.	$236,140	$189,002
East London,	6,000,000	42,000	14[illegible]	5 8[illegible]	2,280,902	201,964	9 "	62,445	139,520
West Middlesex,	2,250,000	15,000	15[illegible]	11 3[illegible]	2,408,888	164,445	7 "	57,777	106,667
Chelsea,	1,760,000	12,400	142	7 7[illegible]	1,038,831	82,618	8 "	55,697	26,921
Grand Junction,	2,800,000	7,700	363	13 5[illegible]	1,386,666	109,787	8 "	47,440	62,347
Lambeth,	1,244,[illegible]00	16,000	78	5 0[illegible]	577,778				
South London,	1,000,000	10,000	100	4 2[illegible]	819,555	$983,956	41 pr ct	$459,499	$524,457
Southwark,	720,000	7,000	103	4 00	311,111				
	28,[illegible]74,000	177,100	1273		$13,440,286				

The average quantity of water supplied each water taker on the north side of the Thames, as appears by the preceding table, amounts to 179 gallons per day; while on the s uth side it only amounts to 90 gallons per day. The reasons given why the supply is so much less on the Southwark and Surry side of the river, than on that of the London and Westminster side are, that the houses are much smaller, the streets not so frequently washed, the quantity supplied for use at fires is much less, the service to the houses by some of the companies is only periodical, or once in each week, when it is stored in cisterns or other vessels for future use; and to which may be added, perhaps, that there is less used for bathing establishments and manufactories.

The average rates on the north side vary from five dollars and eighty cents, to thirteen dollars and fifty-six cents; and on the south side, from five dollars to four dollars and twenty-five cents; the general average being about eight dollars. The total earnings of the five companies on the north of the river Thames, it appears, average rising eight per cent. on the capital employed; the nett earnings, however, after paying all expenses, and deducting one and one-eight per cent. on the capital for wear and tear of machinery, only amounts to $524,457, or about four and a haif per cent. on the capital. If the reserved fund of one and one-eight per cent. on the capital be added to the nett earnings, it will increase the amount to $654,259, or about five and a half per cent. total gain, on the capital employed.

The Companies on the north of the Thames employ fifteen steam engines, which exert a power of 1105 horses; and those on the south side employ six steam engines of 235 horse power. It appears to be necessary therefore, that twenty-one of these powerful machines, equal to the strength of 1340 horses, should be in constant operation, in order to raise the quantity of water daily consumed in the British metropolis. Seven of these companies have to raise the water of the Thames to a height of 80 to 120 feet by steam power, which may be the cause why the annual expense of keeping the works in operation, is

as heavy as it appears ; and when we take into view the large amount of capital seeking investment in England, and the low rate of interest demanded, it is is by no means strange that four and a half per cent. should be considered a sufficient remunreation for its use ; but when we are told by Dr. Rees, in his Encyclopœdia, that " the original value of the shares in the New River Water Works, was one hundred pounds each, and that at present they are worth one hundred times that value"; and by the author of " An historical account of subways," that "a share, which was originally purchased for one hundred pounds, has been lately sold for fifteen thousand, and their value being still increasing," we are unable to account for the result produced by the foregoing table as it respects the nett earnings of the companies. The capital must have been materially increased since the completion of the works, or the income erroneously stated.

The Commissioners will venture a conjecture on the subject however, which they think will prove to be correct. They find it stated in the " picture of London, by T. Britton," that the original capital of the New River Company was £500,-000 or $2,222,223, which is less than half the amount of the capital reported to the British Commissioners by this Company. It is presumed, therefore, that the capital first invested in the works, is that upon which the dividends are made, and the difference between that and the amount reported, is made up from additional expenditures, for new and increased machinery; the replacing their wood pipes by iron, extending the works, &c. all which expenditures are made from the earnings of the company, or from what is termed the " reserved fund," and not from any additional capital paid in by the stockholders. This, we think, will appear to be the fact, from a view of the items, composing the following estimate of the capital employed by the New River Company, as submitted to the Parliament of Great Braitain.

To capital as estimated in 1815,		£846,640 7 0
" " since expended, Fereday for iron,		127.918 0 0
" Pipe laying account, . .		52,994 0 0
" value paid for cocks, . .		3,849 19 0
" expenditures in machinery and buildings, ...		9,019 0 0
" value of pipes purchased of other Companies, when they abandoned the supply of that district now served by this Company. .	£102,042 6 3½	
Deduct proportion of the above stated capital, sold to various companies, when this company abandoned,	58,940 0 3	—43,102 6 0½
Total,		£1,083,523 12 0½

If our supposition be correct, this company, and probably all the others, have been paying their original stockholders eight and a half per cent on their capital, which would amount to $188,889, instead of four and a half, as made to appear by the statement of their receipts and expenditures exhibited by the above table. This may possibly account for the great rise in the price of shares as previously stated.

It may be useful to state briefly the grounds of complaint, against these companies by the citizens of London. One of the principal complaints is, the foul state of the river water. It is averred that 139 common sewers, discharge the contents of the privies, water closets, and the whole filth of the City into the Thames, within the district, from whence the water is taken; that it is loaded with matter, has a bad smell, and requires time to settle before it can be used. That the avowed object had in view by Parliament in creating so many companies, for supplying the metropolis with water, was to encourage competition; as it is only from competition that the public are well served. It appears, however, that after competing

with each other for a few years, during which time the citizens had no reason to complain of the quality, quantity or price of the article, they finally combined together; divided the City into eight districts, assigning one to each company, and entered into mutual bonds, to supply only the district thus assigned, and no other, under a forfeiture of a heavy penalty, "by which all competition was put an end to, and a complete monopoly of this necessary of life, virtually established."

In other respects, the companies act as distinct and separate corporations. Each company charges such price as they may deem proper; and this may account, in a measure, for the difference in the rates. No two companies agree in the amount of rates; the price they may charge is unlimited, and the quantity of water furnished, in many instances, uncertain. Their rates are not regulated by the quantity of water consumed, or by the distance conveyed, but appears to be left at the option of the agents of the companies, to charge what they may deem proper. There is therefore, no check upon them, by the fear of competition, or the loss of custom, to induce them to moderate the price, increase the supply and improve the quality of the article, which, it is averred, has materially deteriorated since the combination.

The influence of the officers of these companies, backed by that of their stockholders, prevented any measures being adopted to reform the abuses complained of. The complainants were answered by a Parliamentary Committee, that by the peculiar undertakings of the companies, for the supply of water, when large capitals must necessarily be vested in fixed machinery, the principle of competition, in its application to such companies could not be admitted without strong guards, or the risk of destruction to the competing parties, and thereby ultimately, of a serious injury to the public. That is to say, the vital importance of a supply of pure water to the inhabitants, is of less moment than the effects of a competition by new companies upon the interests of the old ones.

The evidence thus afforded by the foregoing facts, and others that might be reverted to in our own country, of the effects

produced by placing a monopoly of this necessary of life into the hands, and under the control of private incorporations, ought to be, and the Commissioners hope will be, the means of stimulating the Common Council of this City to a final issue in the matter. Water is one of the elements, full as necessary to existence as light and air, and its supply therefore, ought never be made a subject of trade or speculation.

The Commissioners have derived much useful information from the reports of the Watering Committee of the City of Philadelphia, and from Frederick Graff, Esquire, the able Superintendent of the works at Fair Mount. This gentleman has promptly answered every inquiry of the Commissioners, and furnished them with the annual reports, made to the select and Common Council, of that City, from 1830 to 1834 inclusive. These reports form the best data extant, that have come to to the knowledge of the Commissioners, upon which to calculate the probable amount of revenue that will accrue to this City, upon the completion of the works, for supplying it with pure and wholsome water.

The following table has been compiled from the report of 1834, and gives the result in detail of 1833.

DESCRIPTION OF PHILADELPHIA WATER-TAKERS.	Number of Water Takers.	Average rate paid by each.	Total of the payments.	Variation of the rates.
Dwelling houses.	10,919	$6 00	$65,514 00	$5 to $15 00
Tenements,	202	3 25	656 50	2 50 to 3 75
Tavern,	94	13 00	1,217 00	11 25 to 29 50
Baths,	1455	3 63	5,281 50	3 00 to 4 50
Stables,	44	24 00	1,056 00	8 00 to 50 00
Horses,	67	1 50	100 50	1 00 to 3 00
Manufactories,	10	26 25	262 50	10 00 to 112 50
Bake houses,	11	4 50	49 50	3 00 to 4 50
Hatters,	162	9 00	1,458 00	8 00 to 16 00
Sugar houses,	24	37 50	900 00	25 00 to 335 00
Brewers,	11	62 50	687 50	20 00 to 75 00
Curriers and Morocco dressers,	77	17 50	1,309 00	12 00 to 37 50
Dyers,	133	10 00	1,330 00	" "
Distilleries,	60	18 00	1,080 00	15 00 to 100 00

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The following table has been compiled from the report of 1834, and gives the esult in detail of 183at

DESCRIPTION OF PAILADELPHIA WATER-TAKERS.	No. of water takers.	Aver paid by each.	Total of payments.	Variation of the rates.
Printing offices,	113	$ 8 00	904 00	$15 00 to 100 00
Steam engines,	7	33 00	231 00	20 00 to 40 00
Tan yards,	5	56 30	281 50	52 50 to 70 00
Slaughter houses,	2	12 00	24 00	10 50 to 12 00
Soap factories,	44	17 00	748 00	10 00 to 30 00
Porter cellars,	1	5 25	5 25	" "
Courts, equal to 463 families, at $3 each,	53	26 25	1391 25	18 00 to 37 50
Marble yards,	2	11 00	22 00	
Wash pavements,	80	2 25	180 00	2 00 to 3 00
School house,	1	10 00	10 00	
Hospitals,	3	50 00	150 00	
Deaf and Dumb Institution,	1	60 00	60 00	
Alms house,	1	100 00	100 00	
Navy yard,	1	75 00	75 00	
United States Mint,		70 00	70 00	
Total of water takers,	13584	Total recpts.	$85,153	

The liberal scale adopted in Philadelphia, for supplying the inhabitants with water, reduces the income much below what it would be, if a fair remuneration, was required from all who receive it. In the City proper, the rates are remarkably low, a dwelling containing a family of six persons being charged only five dollars per annum. Dwellings on the rear of lots, and not fronting any street, three dollars; and the same for houses fronting on courts or houses built in the centre of a block forming three sides of a hollow square, the fourth side being the passage to the street. Those who have a stable back of their dwellings, and keep two horses, pay for their dwellings five dollars, for two horses five dollars, and one dollar each for any additional number; for a bath, three dollars, and for the privilege of washing pavements, yards, watering garden, &c. two dollars, making together fifteen dollars per annum. No person pays for the water except it is brought to his premises. For public use, there are 400 hydrant pumps, distributed in different parts of the City, which, according to the estimation of Mr. Graff, supply on an average, ten families each, or 4000 in the aggregate. This is evinced by the fact, that not , than half the dwellings in the City proper take the water on the premises, while in the districts where there are no hydrant pumps erected, the houses are far more generally supplied than in the City. There are also 713 fire plugs in the City and discricts, ready for use at all times and seasons; and notwithstanding this liberal supply and very moderate charge, the income for 1833, amounted to $85,153.

In preparing the foregoing table, and bringing together under their proper head, the different descriptions of water takers in the city proper, and the four districts of Spring Garden, Southwark, Northern Liberties and Moyamensing, the average rates, in several instances, will range higher than those we have stated as charged for dwellings, horses and baths, &c. in the city proper. The cause of this arises from the fact, that inasmuch as the districts are not called on to payany portion of the taxes levied to discharge the interest on the city debt, created for constructing the works, they are required to pay a rate

fifty per cent. greater than that charged in the city. If the city pay five dollars for a dwelling, the districts pay seven and a half, and so in proportion for other privileges.

The data upon which the rates are calculated, is 180 gallons daily, for a family of six persons. Manufacturing establishments, livery stables, hotels, &c. are rated in accordance with the probable consumption of water, on the aforesaid data; thus, if a water taker use four times the quantity that a family of six persons would use, say 720 gallons, he will pay twenty dollars, and in the same proportion for a greater or less quantity.

The Commissioners have compiled the following table, relative to the probable receipts in this city, based on the best information they have been enabled to collect on the subject, and trust it will approach sufficiently near the reality, in the aggregate at least, to authorize the arrival at a conclusion, what will be "the probable amount of revenue that will accrue to the city upon the completion of the works."

DESCRIPTION OF WATER TAKERS.	Number of water takers.	Average per annum paid by each water taker.	Total of the payments.
Dwelling houses, . .	20,000	$8 00	$160,000 00
Back tenements, . .	2,000	4 00	8,000 00
Taverns, . . .	2,646	15 00	39,690 00
Baths, . . .	2,000	4 00	8,000 00
Livery stables, . . .	86	52 00	4,500 00
Horses, . . .	4,000	1 50	6,000 00
Manufactories, . . .	70	90 00	6,300 00
Bake houses, . . .	267	12 00	3,204 00
Hatters, . . .	73	15 00	1,095 00
Sugar houses, . . .	7	150 00	1,050 00
Brew houses. . . .	12	300 00	3,600 00
Tanners, curriers and morocco manufactories,	20	40 00	800 00
Dyers, . . .	20	30 00	600 00
Distilleries, . . .	63	100 00	6,300 00
Printing offices, . . .	178	10 00	1,780 00
Steam engines, . . .	60	35 00	2,100 00
Slaughter houses, . .	100	12 00	1,200 00
Soap and candle factories,	58	60 00	3,480 00
Porter cellars, . . .	10	10 00	100 00
Marble and stone cutters, .	43	35 00	1,505 00
School houses, . . .	68	15 00	1,020 00
Large hotels, . . .	40	150 00	6,000 00
Boarding houses, . .	240	10 00	2,400 00
Boarding schools, . .	22	10 00	220 00
Victualling and refectories,	100	25 00	2,500 00
Shipping, . . .	4,534	8 00	36,272 00
Gas works, . . .	2	1000 00	2,000 00
Chemical works, . .	1	800 00	800 00
Total, . . .			$310,516 00

The above average calculations, in most cases, are founded upon information derived from personal inquiry at the houses, hotels, taverns, livery stables, shipping, merchants, &c. as to the amount annually paid for water obtained from the water carriers, and other sources of supply, and as to the sum that would be willingly paid for water, if brought to the premises or establishments of the persons inquired of; and the rates, as near as could be ascertained, are such as the different descriptions of water takers appeared willing to pay. The natural wish, however, to obtain the article on the lowest possible terms, operated, as the Commissioners think, to reduce the rate below what the real value of the water would be to the taker.

By the act under which they hold their appointment, the Commissioners are required to report "the reasons and calculations upon which their opinion and estimates may be founded;" and in complying with this provision, it will be necessary to state briefly, the reasons which have led to the result arrived at on each item in the foregoing table; and,

1. Dwelling Houses. In order to ascertain the number of dwelling houses, store houses, &c. they have procured a correct measurement of the whole front line of the several streets below and including twenty-first street; and as there are many houses built two on a lot of 25 feet front, and others three on two lots, they have presumed that twenty feet front, by 75 feet in depth, would be a fair average of the whole. The front ground within the limits designated, exclusive of that occupied by markets, churches and public places, measures 1,216,339 feet; and, upon this data, there are 43,216 building lots of 20 by 75 feet; and upon the presumption that they are all built upon, there would be that number of houses, stores, &c. to be supplied with water. The number of vacant lots in the fourteen lower wards of this City, were stated by Williams, in his Register for 1831, at 6353, many of which must now be occupied by buildings; but as the Commissioners have extended the line in the 12th Ward, say from 14th to 21st street and, in order that their data may be as correct as practicable, they have obtained an estimate from the books of the Asses-

sors, showing the number of lots unoccupied in each Ward, and within the prescribed limits, when the Assessors made their examination in the early part of the last summer. The result is that there were 10,614 lots assessed as vacant, or, upon the principle of allowing only twenty feet for a front on the street, there must be 12,737 unoccupied lots, leaving the estimated number presumed to be occupied by buildings, that will require to be furnished with water, at 30,479. The Commissioners, however, have adopted 20,000 as the number to be supplied; leaving the 10,479, and such of the vacant lots as may be built upon before the project shall be completed, as contingencies, to supply any deficiency which may result from errors, if any, in the calculation.

2. Back Tenements. It is notorious that there are many of this description of houses built on the rear of lots, and on alleys extending from the street to the rear of, and for the whole length of the lots thus occupied. They are principally tenanted by poor families; and the Commissioners have accordingly reduced the rate on such buildings to a moderate amount.

3. Taverns. There were 3146 tavern and excise licenses issued in 1833; we deduct from this, 500 for hotels; for those who only take the excise license, and for small taverns; and have estimated the number that would pay an advanced price for the water, at 2,646.

4. Baths. We find there are 1455 private baths in Philadelphia, and cannot doubt, therefore, when we consider the healthful effects arising from the enjoyment of this luxury, and that the population of this City is three times greater than that of the City proper of Philadelphia, but that the low rate at which a bath may be procured will induce a much larger number to claim the privilege of one or more on their premises than we have estimated. The public baths, of which there are several in this city, (and there would be more, if a plentiful supply of soft water could be obtained) will add several thousand dollars to our estimate on this item.

5. Livery Stables. There are 86 of these establishments

in this City, where about 3000 horses are maintained. They consume a large quantity of water, and pay for it from 25 to 100 dollars each stable. A number of them obtain their water from the public pumps, others from the Manhattan Company, but none, as we would learn, but would willingly pay a fair price for a pure article. We have estimated the low rate of one dollar and fifty cents per horse, and find the average of the eighty-six stables will be about $52 each.

6. Horses. There were 3200 cartmen's licenses issued in 1833. If we add to these the horses kept by merchants, gentlemen, and others, the number of horses that would require the use of the water, as the Commissioners think, would not fall short of 5000; they have stated the number, however, exclusive of those kept in livery stables, at 4000, and the rate per annum at the small sum of one dollar and fifty cents each.

7. Manufactories. It appears there are about sixty silver smiths and jewellers in this City, who use in the prosecution of their business a large quantity of water daily. Some of them are supplied from wells on their own premises. One house, who uses 100 gallons per day, would willingly abandon their well, and pay for water delivered on the premises $100 per annum. Type and stereotype founders, about ten, who would be willing to pay about $25 per annum. The general average of the whole would be about $90 per year for each.

8. Bakehouses. There are, as near as could be ascertained, 267 bakehouses, each of which consume a considerable quantity of water per day, and would be willing to pay ten dollars per annum for a supply. But, as the Manhattan Company charge ten dollars for each oven used by a baker, and as many of them employ more than one, the Commissioners have fixed the rate at $12 per annum.

9. Hatters. There appears to be but few hat manufactories in this City, the business of making hat bodies being generally transacted in the country, where a plentiful supply of water may be obtained. The number of finishing establishments is about 73, who would be willing to pay $15 per annum, each.

10. Sugar Houses. As near as the Commissioners could ascertain, there are but seven sugar houses. It was difficult to obtain correct information as to the quantity of water used by these establishments. The result of our inquiries was, that on an average, they would be willing to pay about $150 per annum for a supply.

11. Brewhouses. The number of brewhouses, at present, are twelve, who use from 30 to 80 barrels, or 900 to 2400 gallons of water daily. One of these establishments paid the Manhattan Company $300 per annum for a supply from their works. This water proving unfit for the purposes required, it was abandoned, and carts employed to bring water from the wells in the upper part of the City, at an annual expense of from four to five hundred dollars. The average which the brewers would be willing to pay for soft water delivered on their premises, is about $300 per annum. Since the foregoing was written, one of the Commissioners received a letter from a house extensively engaged in the brewing business, in which they state, "that sooner than be without the Croton water, they would be willing to pay four or five hundred dollars per year for the use of it in their brewery, and they have no doubt but all the other brewers in the City would be willing to pay for it as liberally as they would."

12. Tanners, Curriers and Morocco Manufacturers. We are informed, there is but one tan-yard now in this City, and nineteen curriers and morocco manufacturers, and that they use, on an average, 82 hogsheads of water per day, for which they pay five hundred and eighty-five dollars and fifty cents per annum, and would be willing to pay fifty per cent. addition, or forty dollars per annum each, could a soft and pure article be obtained, instead of that now in use.

13. Dyers. But little information could be elicited from this class of artists. The Annual Register for 1834, gives the number at forty-three. In order however, that our estimate may be within, rather than exceed the probable number, we have stated it at twenty, and the presumed sum they would be willing to pay per annum, at thirty dollars each.

14. Distillers. By the New-York Annual Register, it would appear there are 63 distillers in this City; this, however, must include both small, such as cordial distillers, and also the large establishments; and we have, therefore, adopted an average rate of one hundred dollars, although we are informed, it costs the large establishments from five hundred to one thousand dollars annually. Mr. Cram, who is engaged largely in the business, stated to one of the Commissioners, that he would gladly pay for the water used in his distillery, which is about five hundred hogsheads daily, one thousand dollars per year, and that he was satisfied several others in the same business with himself, would find it their interest to do the same.

15. Printing Offices. From the same source, viz. the Annual Register, we derive the information that there are about 178 of these officss, which we have presumed would be willing to pay ten dollars each, for a supply of pure and wholesome water.

16. Steam Engines. There are sixty of these machines used for various mechanical purposes in this City, exclusive of those employed in raising water for distilleries, sugar refiners and marble manufacturers, which are included under their proper heads. They consume about 45,000 gallons of water daily, which would be equal to the allowance of 180 gallons per diem to 250 families. The average which ought to be paid for each engine is about thirty-five dollars annually.

17. Slaughter Houses. It appears there are about two hundred and thirty-seven butchers in this City, and about one hundred slaughter houses, which we have presumed would be willing to pay the same price for a supply of water, as that charged in Philadelphia, which is twelve dollars per annum.

18. Soap and Candle Factories. There are but 58 of these establishments in the City. Some of them pay one dollar per day for pumping water from wells, which would amount to more than three hundred dollars per year; while others say, it does not cost them more than forty dollars per

annum. We have taken the average, which they would be willing to pay, at sixty dollars.

19. Porter Cellars. We are able to discover only ten of these establishments, and they use but a moderate quantity of water, and would be willing to pay not exceeding ten dollars per annum for a supply.

20. Marble and Stone Cutters. We have ascertained that there are ten manufacturers of marble, who use, on an average, about 400 gallons of water each per day. Their present supply is obtained from wells on their premises; but they would willingly abandon the wells, and pay one hundred dollars per annum, for a supply delivered at their establishments. There are also thirty-three stone cutting establishments, which use, on an average, fifty gallons of water per day, and would willingly pay fifteen dollars per annum for a supply. The average for the forty-three is about thirty-five dollars per year for each.

21. School-houses. There are twelve public schools, twenty-three primary, and seven African free schools. There are also twenty-six classical schools. These schools, the Commissioners have presumed, would willingly pay at the rate of five cents per day for a supply of wholesome water to their pupils, or fifteen dollars per year.

22. Large Hotels. The Register for 1834, gives the number of fifty-six; but our information is, that there are about forty of these establishments, which consume from 100 to 300 gallons of water per day, which is supplied by the water carriers, at two cents the bucket, or one dollar twenty-five cents the hogshead, amounting annually from fifty dollars to four hundred dollars. Some of these hotels are supplied by the persons who serve them with milk, by which they obtain water on more moderate terms than others. Tammany Hall, where there is a hogshead a day consumed, and which would cost, in the ordinary way, rising four hundred dollars per annum, pays the milkman seventy-two dollars, and the Manhattan Company forty dollars, making a total of only one hundred and twelve dollars. Washington Hotel is supplied

in the same manner. The Commissioners think, however, they may safely place the average rate for large hotels at one hundred and fifty dollars per annum.

23. Boarding-houses. There are about 240 of these establishments, which must consume an extra quantity of water each day, and for which they ought to pay ten dollars per annum.

24. Boarding-schools. The Register so often referred to, informs us, there are twenty-two female seminaries in this City, most of which, if not all of them, board the whole or a part of the students, and they will, therefore, require an extra supply of water. We have, accordingly, placed the annual charge at ten dollars, something higher than that for a single family.

25. Victualling and Refectory Houses. There appears to be about one hundred of these houses in this City, which must use a considerable quantity of water daily, and the Commissioners have presumed, that twenty-five dollars per annum would be a moderate charge to those establishments, for supplying them with a wholesome and pure article.

26. Shipping. We have been informed at the Custom House, that there are about 1034 clearances for foreign ports, and about 3500 coasting clearances during the year; the former pay for water, per annum, as near as we could learn, from ten to fifty dollars each, and the latter, from one to three dollars each, making a general average of the whole about eight dollars for each vessel per annum.

27. Gas Works. There are but two of these establishments, the New-York Gas Light, and the Manhattan Gas Light Company. The quantity of water used by the New-York Gas Light Company, is 20,000 gallons daily. They are, at present, supplied from a well on their own premises, the water being raised by the power of steam, at an expense of eight hundred dollars per annum, exclusive of the interest on the cost of engine, &c. We have, therefore, fixed the rate

to be paid by these companies, at one thousand dollars per annum.

28. Chemical Manufactory. There is but one of these establishments in this City, known to the Commissioners. The company use large quantities of water, partly obtained in the same manner as at the gas works, but, as it is stated, at an expense of about six hundred dollars per annum. We have, accordingly, fixed the rate at eight hundred dollars.

It is upon these data, which the Commissioners have attempted to elucidate, they have founded their calculations and opinions, that when the project shall have been completed, the eventual receipts will more than pay the interest on the capital expended, and the annual cost of attending the works; and, in due time, leave a surplus for the redemption of the debt that may be incurred.

An opinion is gaining ground with many, of those who require large quantities of water for conducting their business, that the supply on this island is annually diminishing. The Commissioners have understood that, at the chemical works on the North River, at 33d street, and at an extensive turpentine distillery on the East River, some distance above the Alms House, water cannot be procured in sufficient quantity from the large wells on their premises, where, but a few years past, it was obtained in abundance; and, consequently, they are now compelled to cart a portion of their water from a distant place on the island. At the gas works, situated on the Collect grounds, where they have a well twenty feet in depth, by eighteen feet in diameter, which, until the present season, furnished water freely, enabling the engine to raise 20,000 gallons in ten hours, now requires fourteen to sixteen hours to raise the same quantity; and in order to continue the supply, it has been found necessary to return the water to the well, after using it for condensing the gas. The Commissioners are also informed, that the Corporation well on 13th street, which formerly yielded 120,000 gallons of water each day, will now only produce from five to ten thousand. To remedy this evil, a well has been sunk at Jefferson Market,

which has deprived most of the wells in that vicinity, of water; thus drying up one source of supply, in order to increase that of another. These are important facts, and ought not to be lost sight of by the municipal authorities, or by the people of this metropolis.

The Commissioners have experienced some difficulty in ascertaining, during their inquiries, the quantity of water used, and the price that would willingly be paid for a supply by certain establishments, arising from a fear in those inquired of, that full and correct information might operate to increase the rate of charge upon those communicating it; and it may be proper, therefore, to keep this fact in view, while examining the foregoing table of rates. But whatever may have been the different opinions expressed as to the rate which ought to be charged, there appeared no difference in sentiment as to the propriety, utility and necessity of procuring a supply of good and wholesome water for this City. As far as the information of the Commissioners extends, all are in favor of the project.

That there are many establishments in this City, which have escaped the notice of the Commissioners, and which would readily take the water, should the project be carried into effect, is by no means improbable; and that there would be numerous manufacturing establishments rising up in the suburbs of this City, if a sufficient supply could be obtained, can hardly be doubted by any. This, then, is an additional consideration to be kept in view, while estimating the future receipts that may accrue to the City on the completion of the works.

It will probably require a few years after the works shall be completed, before the income will meet the interest on the capital expended. This is the natural result of all new undertakings. The doubts entertained of their utility, always retard their general use, until time and observation convince the public of their advantages and benefit. This was, in a measure at least, the case on the application of steam power to the propelling of vessels; on the use of gas in lighting our

houses and streets, and on the first construction of canals and rail roads. Strong doubts were entertained of their success, and some time was required before the public prejudice could be allayed. They eventually succeeded, however, and are now among the most prominent improvements of the age.

We are informed, that when Hugh Middleton, the projector of the New River Water Works, applied to the Corporation of London, for a transfer of the power granted them by Parliament, to supply the City with pure water, they readily made the transfer, but privately laughed at him for undertaking what they deemed visionary, if not impracticable. Posterity, however, enjoy the benefit and advantage of this great work, effected through the perseverance of an individual, and the Corporation having lost their birthright, are not only bereft of the credit, as well as the privilege and control, but the profit of the project also.

The receipt of the Fairmount Works, at Philadelphia, although they have been in operation a number of years, have not, as yet, paid the annual expenditure. That City, however, has adopted the true principle in this matter, namely, that health is of more value to the citizen than gold, and they have accordingly furnished the water in abundance, and on the most reasonable terms, depending on annual loans for completing the works, and on taxes, to pay any deficiency in the interest on the debt thus created, rather than resort to an increase of the assessment upon those who use the water.

A work of this nature is a boon to posterity of the first magnitude; and it is but reasonable and just, therefore, as they will reap the benefit of the project, and be enabled, as the population increases, and the income augments, to discharge the debt, without inconvenience, that the first cost of the works should remain a lien on those who succeed us. The only obligation on the present generation, in constructing a work of this magnitude and importance, is, that they pay the interest on the debt incurred, leaving the principal to be provided for by those who come after them.

The Fairmount Works are rapidly approaching that state, when their income will, at least, pay the interest on the debt, if not all necessary annual expenditures; and, in order that the Common Council may be enabled to form a judgment, by what has been effected at those works, of what may reasonably be expected here, should the project of supplying this City with pure and wholesome water, be carried into effect, the Commissioners have compiled, from reports furnished them by Mr. Graff, the following table, shewing the increase in the number of water takers annually, and the revenue received each year, from 1828 to 1833 inclusive.

Years.	No. of Water takers.	Annual increase of water takers.	Amt. of Cash received each Year.	Ann. incr. in Receipts.
1828	8,769		$51,019 75	
1829	9,633	864	56,714 79	$5,695 04
1830	10,343	710	63,613 75	6,898 96
1831	11,406	1,063	70,403 75	6,790 00
1832	12,492	1,086	77,567 75	7,164 00
1833	13,584	1,092	85,153 00	7,585 25

By the foregoing table it appears that the number of water takers in 1828 was 8,769, when, in 1833, they amounted to 13,584, being an increase of 4,815; and the income in 1828 was only $51,019 75, while, in 1833, it amounted to $85,153; having increased in five years $34,133 25, or on an average $6,826 65 per annum. That there will be no diminution of this annual increase for many years to come, is evinced by the fact, that not more than one half of the population of the districts are now supplied, and scarce a moiety of the dwellings of the City proper take the water on the premises. We have been informed, since the foregoing table was compiled, that orders have been received at the office of the Superintendent of the works, to extend the conduit pipes to the district of Kensington, which contains a population of about fourteen thousand inhabitants.

The Commissioners believe they have now attended to all the preliminary duties required of them by the Act of the Legislature, except that provision, contained in the fourth section of said act, which authorizes them to make conditional contracts with the owners of land, water rights, &c. for the purchase thereof at stated prices; such contracts to be binding on the owners, but not on the Common Council, unless they shall ratify the same on or before the second of May, 1836. The Commissioners have presumed that no person owning property would be willing to bind himself to the performance of a contract so partial in its operation as that alluded to; by which he would have no choice but a compliance under any circumstances—while the Common Council, as one of the contracting parties, would be at liberty to take advantage of events, and either approve or reject the contract at pleasure; they have therefore made no attempt to carry into effect the aforesaid provision.

The health and comfort of every family in this City, is so immediately interested in possessing a knowledge of the quality of the water they use that the Commissioners have deemed it proper and useful again to state the results of an analysis of the water from the Manhattan and some other wells in this City, made by George Chilton, Esq. Chemist.

A gallon of water from the well belonging to the Manhattan Company in Reed street, yielded 125 grains of solid matter.

The same quantity from their well in Bleeker street, yielded twenty grains.

The same quantity taken from the Corporation well in 13th street, yielded 14 grains.

The same quantity taken from four of the City wells in the densely populated parts of the City, yielded on an average 58 grains each, of solid matter. (See Report of 1833, p. 368, 370, 374.)

It would seem, that the use of water thus impregnated, can be no other than unwholesome, and more or less hurtful to the digestive organs of those who partake of it, and

although the injurious effects may not be perceptible to persons in the full vigor of health, it must be very pernicious to those of dyspeptic habit, or of weak digestion. That this is not chimerical, the following extracts from opinions of eminent physicians, both in Europe and our own country will show.

Doctor Griffiths says:—With regard to the water we use, we cannot be too scrupulous, the purity of this element being almost of equal importance to us with the air we breathe.

Doctor F. Hoffman:—If there is in nature, a medicine that deserves the name of universal, it is, in my opinion, common water, of the best and purest kind. The use of this is so general, and so necessary to us all, that we can neither live, or preserve our bodies sound and healthy without it.

M. Cabanis:—Water loaded with vegetable matter, or with earthy substances, acts in a very pernicious manner on the stomach and other organs of digestion. The use of it produces different kinds of diseases, both acute and chronical; all of them accompanied with a remarkable state of atony or relaxation, and a great debility of the nervous system.

The following extracts are from opinions of the consulting physicians of Boston, furnished at the request of the Mayor of that City.

Doctor Warren says:—From inquiries, I can state as a result to be relied on, that the water commonly used is apt to produce and maintain disorders of the stomach and digestive organs, and that there are cases of these affections which cannot be removed, so long as its use is continued. The operation on articles of food subjected to the action of brackish or saline water, must be to some extent injurious. Vegetable food, especially, when prepared in this way, is unwholesome, and may be a cause of positive disease.

Doctor Shurtleff:—I believe the water from our wells is in a degree unwholesome, predisposing some to calculous and others to bilious disorders. The rain water is not fit for use. The soot and other impurities on the roofs thicken it, and the

leaves dye it in such a way that it will hardly do to wash with.

Doctor Hayward:—In seveal cases of obstinate and long standing affections of the stomach and bowels, I have directed the patient to use soft water, instead of the hard well water, and have been satisfied that the change has produced a very favorable effect.

Doctor Randall:—There is, of course, at all times in our City, a vast number of persons, who are sufferers from our saline water, a great proportion of whom would be relieved of their troubles by the introduction of pure country water; and this reason alone, in my mind is sufficient to warrant the expense of its introduction.

Doctor Shattuck:—As labor has built the City, and as labor now maintains the City, I would that the City refresh her laborers with a full supply of the article as furnished by the mountain stream, provided such water can be found and conveyed to the City within its convenient means. Let the people have this refreshment, with the addition of pure air, and all is done that men can do, to prevent epidemic disease. Putting aside human life and human comfort, one sweeping epidemic may injure the property of the City to a greater amount than the entire cost of an aqueduct to supply the City with pure water.

"When the dysentery raged violently in the old barracks at the City of Cork, the care of the sick was entrusted to Mr. Bell, a surgeon of that City. The troops were supplied with water from the river Lee, which, in passing through the City, receives the contents of the sewers and the houses, and is brackish from the tide which descends into the channel. Mr. Bell suspected that the water might have caused the dysentery, and he therefore employed a number of water carts to bring water for the troops from a spring at a distance, and at the same time prohibited the use of the water from the river. From this simple, but judicious arrangement, the dysentery very shortly disappeared from among the troops."

The disease with which the inhabitants of this City was

afflicted in 1832 and 1834, is said to be in almost every case preceded by dysentery; and if the quality of the water used by the soldiers in Cork was the cause of that disease among them, why may not the same quality of water, when used in this City, have the same effect in producing what was termed the premonitory symptoms with us? That the most of the water from our wells and pumps receives the drainings of numerous sinks and cistpools, which filtrate through the earth, and poison the springs, causing the water to be brackish, must be admitted; and that it contains much earthy and foreign matter held in solution, as proved by the analysis of Mr. Chilton, already referred to. The constant use of this fluid, therefore, must be more or less injurious to health, and is as likely to have been one of the causes of cholera in New-York as it was of dysentery in the City of Cork. Why is it that the City of Philadelphia experienced so little of this disease, while it raged with so much violence with us? The only way we can account for this difference in the health of the two Cities is, that Philadelphia is supplied with abundance of pure and wholesome water, not only for drinking and culinary purposes, but for bathing, and for washing the streets of the whole City, while New-York is entirely destitute of the means for effecting any of these purposes. It is stated by Mr. Graff, the Superintendent of the Water Works, that during the months of July and August last, the quantity of water supplied amounted to seven millions of gallons daily, when the ordinary supply did not exceed four millions. No disagreeable odour assails the persons who pass through the streets of that City; every thing calculated to annoy the senses is swept away by the running stream; but, in New-York, a person coming in the City from the pure air of the country, is compelled to hold his breath, or make use of some perfume to break off the disagreeable smell arising from the streets.

The quantity of water, in order to be effectual, in preserving the City from disease, must not be limited to the ordinary wants of domestic consumption merely, nor ought it be

restricted to the poor, or those in moderate circumstances, by a high charge for its use; but on the contrary, the quantity supplied should be abundant, the quality good, the cost moderate, and to the poor gratis.

In order to effect the aforesaid object, a portion of the interest, at least, on the capital necessary to complete the project, and the annual expense attending the delivery of the water, should be paid by a tax on the real and personal estate of the City, in the same manner that the watching, lighting and repairing the streets and roads, are paid; or as the expense of the police, criminal courts, board of health and public schools are paid. These are matters in which the poor man partakes equally with his rich neighbor, all being proper and necessary municipal expenses for preserving the peace, health, comfort and morals of the community; and are of no greater importance in a public point of view, than a copious supply of pure and wholesome water, an element admitted on all hands to be as necessary as any of the municipal measures we have enumerated.

We spend millions for erecting and ornamenting our public buildings, while a fourth of the money, would raise structures equally convenient, but not equally ornamental. We open public squares, and enlarge and widen our streets, at an immense expense, in order to increase the health, convenience and beauty of the City; all of which might be saved, if we were content to live, as our ancestors did, in narrow streets, without parks, squares or public places. In thus adding to the convenience and beauty of the City, however, and increasing its salubrity, we act wisely, because it improves the health, accommodation and comfort of the inhabitants; but with the most unaccountable inconsistency, we submit to the use of water which entails upon its recipients more insidious evils than narrow streets, plain buildings, or closed parks and squares, merely because the cost of procuring a pure and wholesome article may add to our taxes a few cents on each hundred dollars of property annually.

The Commissioners have used every means within their

power to complete their report and present it at a much earlier day than the present; but owing to the inability of the engineers to finish their surveys and examinations by the time stipulated in their agreement, the delay had been unavoidable, and can now only be remedied by the undivided attention and early decision of the two boards of Common Council.

The bad quality of our common well water; the fact that the supply from the usual source is annually lessening, and the very great destruction of property by the late fires, owing mainly to the want of a full supply of water, are urgent considerations for a prompt action on this subject by the Common Council, in order that the question may be submitted to the decision of the people, at the charter election to be held on the second Tuesday of April next.

The papers accompanying this report, are:

1. Report from David B. Douglass, Esq.
2. Report from John Martineau, Esq.
3. Report from G. W. Cartwright, Esq.
4. Communication from Albert Stein, Esq.
5. Letter from D. I. Rhodes, referred to by our report.
6. Communication from Mr. John Hunter.
7. Communication from Mr. Bradford Seymour.
8. Estimate of the number of building lots south of 21st street.
9. Report of U. Wenman, Esq.

The Commissioners have deposited in the office of the Street Commissioner:

1. Map and profile of the route proposed, by D. B. Douglass.
2. Map and profile of the route proposed by J. Martineau.
3. Map, by G. W. Cartwright, of the land that will be overflowed by the erection of a dam at Garretson's Mill.
4. Map of the City, containing the front width of each block of ground south of 21st street.

5. Map of the City, dsignating the mains and conduit pipes neccssary for supplying the several parts of the City with the water. All which is respectfully submitted.

STEPHEN ALLEN,
WILLIAM W. FOX,
SAUL ALLEY,
CHAS. DUSENBERRY,
BENJAMIN M. BROWN,
Commissioners

New-York, February 16, 1835.

REPORT OF MR. D. B. DOUGLASS.

To Messrs.

STEPHEN ALLEN,
SAUL ALLEY,
WM. W. FOX,
BENJ. M. BROWN,
CHARLES DUSENBURY, } *Commissioners for supplying the City of New-York with pure and wholesome water.*

GENTLEMEN :—

In obedience to your requirements, I have now the honor to lay before you the annexed plans and estimates, together with the following report on the location and construction of an aqueduct from Croton River to the City of New-York.

Recapitulation of the former report.

In my report formerly submitted, relative to this subject, I gave an outline of the preliminary examinations, which had just then been made under the direction of the Board, for the purpose of elucidating in general all the various sources from which supplies of water might be obtained in the neighboring counties of Westchester and Putnam. These examinations of course embraced the situation, character and capacity of all the principal streams, the elevation of their beds, the quality of their waters, and the various routes by which it might be thought practicable to conduct either or any of them to the City, and it resulted from them, among other less important particulars,

1st. That the water of the Bronx and the other streams of the same drainage running south, although unexceptionable in point of quality, were too limited in quantity, at the requisite elevation, to be depended upon for supplying the multiplied and rapidly increasing wants of this metropolis.

2d. That the same waters taken, even at a lower level, so as to avail of their utmost capacity in the respect mentioned, were still not wholly free from doubt; and at all events would require the intervention of steam power to raise them to the necessary height for distribution and use.

3d. That the waters of the Croton, equally as pure as those just mentioned, were fully and unquestionably adequate to the proposed supply, at all seasons of the year, and at any needful elevation, without the aid of steam or any other extraneous power.

4th. That the latter water, far from being unavailable on account of the difficulty of the intervening ground, could be safely and certainly conducted to the City by either of two modes which were described, and, upon which the details of construction, were so far ascertained as to afford the data for a maximum estimate, beyond which it was presumed the expense of construction would not go.

Object of this report.

Thus far, these surveys were of a preliminary nature, and having in this stage received the sanction of the Board, the next step to the natural order, was to make out, by a more particular course of examination, the details of location and construction for the aqueduct or conduit from the Croton to the City, and to this object therefore, the operations of the recent campaign, under the further instructions of the Board, were especially directed, that is to say:

1st. With regard to the location and construction of the dam and other works connected with the head reservoir on the Croton.

Location of the dam on the Croton.

At Muscoot rapids.

In the preliminary report the location of the dam for the Hudson River route, was assumed provisionally at Muscoot rapid, near the hill of that name, eleven miles from the mouth of the Croton, The river at that point is compressed into a narrow channel, bounded on either hand by bold shores, favourable in every respect for the proposed construction, and it was ascertained that a dam in this position of the height of 14 feet, would afford an aggregate head of 175 feet above tide.

At Garretson's Falls.

Five and a half miles further down, the river having descended 38 feet, flows through another pass of a similar character at Garretson's Mill, not differing greatly in width from that just mentioned, and equally well calculat-

ed in all other respects for the purpose in view. The remarkable contraction of the stream at this place, and the boldness of the natural abutments, consisting of solid rock, almost perpendicular on the south side, caused it to be noticed at a very early day, as the proper location of the dam; and this view was accordingly adopted in the report made by Mr. Clinton in 1832. He assumed the height however, upon information, at 180 feet above tide, whereas it proved upon testing it with the instruments to be but 137 feet (at the surface) in the head race of Garretson's Mill, and only 127 feet at the daming place in the rapids below.

General view of the question.

In selecting between these two positions and in adjusting the proper graduation for the fountain head, in the respective cases, a variety of considerations present themselves. If, for example, we should aim, by giving great elevation to a dam at Garretson's Mills, to retain the full advantage of height given us at that point by the other location, we should have to institute a comparison between the saving in expense, from the diminished length of route on the one hand, and the enhancement of expense from the additional height of the dam, and the greater injury done to buildings, mills, bridges, roads, &c. on the other; or if we should admit a lower graduation for the reservoir at Garretson's Mill, it would then become necessary to increase the sectional capacity of the channel in order to deliver the same quantity of water at the same elevation in New-York, and the enhanced expense from this increase, (which in a structure of this kind is by no means inconsiderable) is then to be compared with the saving in length.

I have attempted to reconcile these various considerations, by giving to each location, separately, the most advantageous disposition of which it was susceptible, and estimating thereupon, and then to bring the two arrangements into comparison on the ground of these estimates. Not to detain the Commissioners, however, with all the particulars of this very elaborate process, I merely state

in this place, a few general results, which will sufficiently elucidate the conclusion to which I have arrived.

Muscoot location examined.

The dam at Muscoot Hill, with the particular height of 14 feet, gives, as has already been stated, an aggregate of 175 feet for the graduation of the reservoir at that place; which enables us to appropriate about 60 feet of fall to the entire length of conduit, say 47 miles, or about one foot three inches per mile. This was the grade uniformly adopted for the location of the former report; but upon a re-examination of the data, I think it a preferable arrangement to construct the first five and a half miles of this location, through the alluvial bottoms, as an open channel-way, after the manner of the annexed diagram No. 2, with a fall of nine inches per mile. This would enable us to throw into the remaining 41½ miles, a declivity of one foot and four inches per mile, the proper channel for which, is exhibited in the diagram No. 1. According to this arrangement, I have estimated anew the aqueduct line connected with the reservoir at Muscoot Hill, and in running up the items of difference which are to be debited to this plan, I find them amounting to an aggregate of $304,750 00.

Garretson's Falls location examined.

With regard to the construction originating at Garretson's Mill, I have assumed the height of its reservoir, after a variety of trials, at 155½ feet above tide, which makes the extreme height of the dam above the bed of the river 33 feet. Above this height, the extent of drowned land, and the amount of damages done to buildings, mills, roads, bridges, &c. begins to increase very rapidly. And if we should go to the extreme of adopting the graduation of the Muscoot line at this point, say 171 feet, the reservoir, in the medium and higher states of the water, would back over an extent of more than nine hundred acres of surface, including the present river bed.

In adverting to this subject, it is proper to remark, that the extent of ground inundated by erections of this kind, in large running streams, is by no means ascertained by the extension of a level surface through the lip of the dam. The water continues running, of course, after the dam is

constructed as well as before, and the velocity with which it runs, is due, according to the ascertained principles of running water, to a particular inclination of surface, (there can be no current without inclination,) and it is this inclined surface, therefore, which determines the extent of back water.

Applying then, ascertained principles to the case in question, we find that a dam of the height suggested, would not only inundate a wide extent of valuable bottom land below Muscoot Hill, but would actually, in the supposed state of the water, throw up an additional depth of several feet above that position, so as to cover all the low flats about the mouth of Cross River, and to some distance above. Within these limits are embraced a considerable amount of mill property, several valuable buildings, several miles of road, sites of bridges, and various other improvements, which it can scarcely be necessary to particularise further, to show the infeasibility of such a construction.

Should we, on the other hand, adopt a much lower graduation than that named, say 140 feet above tide, it would be necessary in that case, so to increase the dimensions of the conduit as would enhance the expenses of its construction nearly one-third.

Between these extremes, the mean of 155½ feet has been chosen as before stated, which gives an extent of reservoir not exceeding 200 acres; an amount of damages comparatively unimportant, and a disposable head of one foot per mile, for the channel-way of the conduit, from the dam to the City. Finally, making out the details and estimates, according to the data, it appears that the various items which give differences against this arrangement, in comparison with that of daming at Muscoot Hill, amount to $212 800, which being deducted from the counter estimate of $304,750, shows a conclusive balance of $91,950 in favor of Garretson's Mill.

Location determined at Garretson's Falls.

A single remark on the relations of this position to the river below, will close this branch of the report, and introduce us to the location of the conduit. From Garret-

View of the Croton below the Falls.

son's Mill downward, the bed of the Croton descends rapidly, 126 feet to the tide level of the Hudson, in the distance of about five miles, or at the average rate of, say 25 feet per mile, which would be the increment of height, therefore, for a dam at any lower point, giving the same advantage of head. The width of the valley is found also to be increased in a corresponding ratio, and as the principle of strength requires that the dimension of the structure in the line of the stream should be fully proportioned to the height, it results, that the mass of the dam thus increased in its three dimensions, will be determined by the cube of its height, and that its cost, therefore, independently of the new item of lands and damages, must be nearly in the same ratio. A few calculations upon these principles, justifies the inference that the position at Garretson's Mill, being at the head of the steep rapids of the river, is the most natural, as well as the most economical and safe location for the dam. A variation, however, in this point of detail, would not otherwise interfere with the location of the conduit about to be described.

Particular disposition of the dam

The particular disposition of the dam in the locality chosen is, at the narrowest part of the river below the mill, abutting upon a substantial bold shore on the north side, and upon solid rock on the south. Connected with the latter abutment, it is proposed to construct the fore bay and gatehouse, with their appurtenances, and at this point the location of the conduit commences.

Line down the Croton.

The trace, and all the particular circumstances of the location down the valley of the Croton, and thence along the margin of the Hudson towards the City, are so fully developed in the annexed plan and profile, that it cannot be necessary to describe them very minutely in the body of this report. In the valley of the Croton, and generally on all the parts of the route above Greensburg, it traverses the same range of slopes as the Hudson River route of the former report, varying, however, in some of its details, in consequence of its being somewhat lower on the declivity.

The first instance of this kind worthy of notice, occurs at the mouth of the Croton, where, in passing the high headland called Tompkins Hill, it was found necessary to incur the construction of a short tunnel, and the trace has, therefore, been carried through the hill, on the shortest line, without regard to the height of the ridge above it, which will account for the boldness of the profile at this place. A similar instance occurs in passing Sing Sing, cutting through the ridge on which the State House (so called) stands. Both these features might have been avoided by long circuits round the face of the respective headland, but with such an increase of distance and other contingencies, as to render entirely unquestionable the economy of the tunnel arrangement. In the Sing Sing instance, for example, the additional distance for a surface location, would have been five-eighths of a mile, and that not without other occasions of heavy incidental expenditure. Headland at the mouth of the Croton. And at Sing Sing

These and some other instances of a like kind, exhibit an increased estimate, in consequence of the lower graduation. But in other cases, as in crossing the various streams and valleys by which the line is intersected, the expense is ameliorated. The crossing at Kill Brook at Sing Sing, is less formidable than by the former location; that of Sleepy Hollow (see sketch No. 9.) in like manner; and the same effect is experienced at Jewel's Brook, the brook at Greensburg, and at other similar localities. Kill Brook at Sing Sing. Sleepy Hollow and the ravines between that and Greensburg.

The most considerable variation from the old route occurs after passing Greensburg. Here, in consequence of the reduction of grade, it was found inexpedient to follow the line of deep cutting, by which that route was carried into the valley of the Saw Mill; and from this point, therefore, a new series of elementary examination, was carried down the margin of the Hudson to Yonkers, and, finally, over all the ground from Yonkers to the City. Variation from the former route below Queensburg. Re-examinations from Greensburg to the City

From the vicinity of Greensburg to Yonkers, these examinations resulted in a very favorable location along the margin of the Hudson; but from the latter place it Location at Yonkers.

became necessary to make a considerable detour up the Saw Mill, in order to reconnect the line with the former location in the valley of Tibbit's Brook; and this circumstance induced me to attempt a new location in a more direct line, southerly from Yonkers to the City.

Alternative to the Tibbit's Brook route.

Upon examination there seemed a possibility of accomplishing this, by either of the routes, viz: in the first place, by a line crossing the Saw Mill at Yonkers, and running about a mile down the rocky ridge below that place; thence turning to the left, round the southern extremity of what are called the Finger Ends, and so uniting with the old line on the east side of Tibbit's Brook.

By the Finger Ends.

And by Kingsbridge.

Secondly, following the same route, except turning to the right instead of the left, at the southern extremity of the first finger, and crossing the valley between that extremity and the head of Van Cortland's ridge. The western slope of this ridge then sustains the level favorably to the crossing of Spuyten Duyvel Creek, which occurs near the Hudson, and proves rather narrower on this route than the corresponding crossing of the old location. South of the Spuyten Duyvel, the same character of location is resumed along the bank of the Hudson, and after crossing the Wind-gap, this line finally unites with the old trace, a short distance above Manhattanville, as indicated on the plan and profile.

Examination of these routes.

The examination of these routes was performed instrumentally, and with every requisite precaution, particularly the latter, which seemed most likely to enter into a favorable comparison with the more circuitous route by Tibbit's Brook; and for the purpose of making this comparison with strictness, the last mentioned route was also thoroughly re-examined and retraced, in connection with the new location by Yonkers, that is to say—resuming this location on the slope of the Hudson above Yonkers, it enters the valley of the Saw Mill, by a deep cut or tunnel, near the Methodist Church; after which, it ascends the valley along the north slope, to a very favorable point for crossing the Saw Mill, near Morrison's Mill, (see sketch No. 10.) A little way beyond this, it

Re-examination of the Tibbit's Brook route,

Entering Saw Mill Valley

Crossing Saw Mill River.

enters the tunnel by which it gains the valley of Tibbit's Brook, emerging into the latter, nearly on the line of the old route.

The continuation of this line down the valley of Tibbit's Brook, need not be very minutely particularised here. It follows the same system of slopes as the old line, with a graduation rather below, which seemed, in some instances, to operate favorably upon the expenses of construction. The grade of the present line, however, descending less rapidly than that of the former, approximates to it, and on reaching Bathgates' Plains, is found in a very favorable relation indeed to the surface of the ground on that range, after which, the two locations are nearly identical to the crossing of Harlaem River and beyond.

Tunnel into the valley of Tibbit's Brook.

Bathgate's Plains.

The crossing of Harlhem river, by this route, was re-examined in the course of our operations and trials made at two new locations, the comparison of which, however, only confirmed the location indicated in my former report. (See sketch No. 11 and 12.)

Crossing Harlaem River.

The general comparison of these two routes just described, may now be stated as follows, viz:—in the first place, comparing the two routes for entering the Tibbit's Brook Valley; that by the Finger Ends, with that by the tunnel, it appears from the notes, that the former is the shortest by 50 chains, or five-eighths of a mile; but upon estimating the cost of construction, (see Appendix No. 3,) in consequence of the additional aqueduct of Tibbit's Brook, and the greater expense of crossing Saw Mill River, the difference, in this respect, is found to be in favor of the tunnel route, viz:

Comparison of the tunnel route with that by the Finger Ends.

Total expense for grading that by the Finger Ends, including aqueducts, . .	$169,323 95
Ditto for that by the tunnel, including extra length of channel-way, . .	99,562 53
Leaving a balance in favor of the latter, of	$ 69,761 42

L

The tunnel route, therefore, of these two is decidedly preferable.

Comparison of the Kingsbridge and Tibbit's Brook routes.

Secondly: comparing the entire Tibbit's Brook route (by the tunnel way,) with the King's Bridge route, as above described, the following facts are educed, viz:—that in point of length, the route last mentioned has the advantage by no less than one mile and sixty-six chains; but in the comparison of cost, here, as in the former case, the difference is in favor of the longer line, (see Appendix No. 2.) as follows, viz:

The latter longer but less expensive.

The total estimate for the King's Bridge route, including aqueducts, .	763,049 79
That of the Tibbit's Brook route, including extra length of channel way,	657,150 79
Leaving a clear balance in favor of the latter, . . .	$105,899 00

Reason of the difference.

This discrepancy of advantages arises from the extra expenditures incurred on the King's Bridge route, by reason of the more expensive aqueduct across Saw Mill River; the additional aqueducts at the hollow between the Finger Ends and Van Courtland's Ridge, and at the hollow called the Wind-gap, below Spuyten Duyvel Creek. This route also incurs a heavy expenditure in the item of rock excavation, as may be seen by the itinerary estimate. Under all the circumstances, the Tibbit's Brook route seems entitled to the preference. I may, however, remark that until the calculation of the estimates, the probability was in favor of the King's Bridge route; which will account for its being put in continuity with the line above Yonkers in constructing the profile.

Manhattanville Valley.

The crossing of the Manhattanville Valley, was next re-examined and re-located upon ground much more favorable than formerly, and continuing south, a new and very detailed re-examination was given to the whole range of ground between Manhattanville and the City, with a reference equally to the adjustment of the line of

conduit, and to the selection of positions suitable for reservoirs. This portion of our field duties involved, perhaps, as great difficulties as any which had been previously encountered. The extreme irregularity of the surface, consisting of masses of rock apparently protruded in every variety of shape and relation (except those which usually obtain,) with deep and equally irregular cavities intervening, rendered it necessary to solve a problem at almost every step of our progress.

Difficult ground between Manhattanville and the City.

The chief object of solicitude in locating this lower part of the route, was to obtain ground in the proper range, and of sufficient elevation to bear up the graded line, until it should reach a point sufficiently central, to serve as a locality for the distributing reservoir. The line ultimately obtained, and which is delineated in the annexed plan, is deemed rather fortunate, both with respect to its allignement and relief, although it is still intersected by many deep and abrupt variations of surface on the last two or three miles, as the profile sufficiently indicates. To the middle of the 39th mile, however, estimating from the Croton reservoir, the grade with a few unimportant exceptions, is well sustained. The average of the surface then begins to decline, but at so moderate a rate for the mile next following, as to furnish no adequate reason for terminating the grade line any where short of that distance. This portion of the route occupies generally the interval between the 8th and 9th Avenues. The middle of the 40th mile, reaching nearly to the Bloomingdale road, and at this point as the surface in almost every direction more southerly, falls considerably below our grade, it becomes necessary to consider the capabilities of the ground, with reference to the terminal reservoir. The reconoissance for this object, embraced generally all the principle high ground between the 8th and 10th Avenues; among which, however, after much examination and comparison, two positions were selected as decidedly preferable to all others. One recommended by its comparatively easy access, and the other by its more

Object of extending the graded line as far as possible.

Character of the profile.

Excavation of ground for the terminal reservoir.

prominent situation in regard to the City. The first of these is delineated on the map, near a certain reservation called Bloomingdale square. Its boundary on the east and west are 9th and 10th Avenues, on the north 60th or 61st street, and on the south 56th street, comprehending an area of least four entire blocks, its distance from the City Hall in a direct line, measures exactly four miles, and from the Croton Reservoir, by the line of our location, 39 miles and 66 chains. Consequently, supposing the water to stand about 4 inches on the lip of the dam at the head of the line, the standard level for the reservoir in the position now described would be 116 feet above tide.

Bloomingdale square.

The second named position is on Murray's Hill, between the 5th and 6th Avenues, and between 38th and 42d street, the commanding and central position of which is well known. Its distance from the City Hall is exactly 3 miles, and from the head reservoir 41 miles, whence the standard level of the distributing reservoir at this point, is found to be 114 feet 10 inches.

Murray's Hill.

These heights, although slightly below that calculated upon in the former report, are from the circumstances hereafter to be explained, considered far more certain, and without doubt are sufficient for all objects requiring a high service in the City.

Height of reservoir for distribution.

For the purpose of showing their relations in this respect, I have caused a few leading positions and some of the more elevated buildings of the City to be laid down, with their appropriate elevations at the termination of the profile. Those referred to, together with some others since ascertained, are given in the following schedule, viz:

Height of buildings in the City.

	ft.	in.		
Thirteenth street at the reservoir,	39	6	above	tide.
Surface of the reservoir. . .	100	0	do.	do.
Washington square, . .	25	0	do.	do.
Roof of new University building,	108	0	do.	do.
Broadway, at the Hospital, .	32	0	do.	do.
Roof of Masonic Hall, say .	96	0	do.	do.

	ft. in.	
Chatham square, . .	33 0	above tide.
Roofs of the higher buildings adjacent, say	95 0	do. do.
Surface of the Park, front of the City Hall, ...	38 0	do. do.
Roof of the attic of the City Hall,	100 00	do. do.
Broadway, at the City Hotel,	31 0	do. do.
Roof of City Hotel, . .	107 0	do. do.
Roof of Holt's Hotel, say .	96 0	do. do.

From these elements we may perceive the relation in which either of the proposed reservoirs, will stand to the particular circumstances and wants of every part of the City. No inhabited buildings or warehouses, probably rise higher than those here given as examples, and a large proportion of the best dwelling houses, as well as most of the lofty warehouses in the business portion of the City, rise very little if any above the limit of 84 feet, which is nearly 21 feet below the level of the distributing head.

Capabilities of the reservoir in regard to height.

Comparing these relations of height, with the respective distances from the reservoir, we find that even in the most unfavorable instance, that of the City Hotel for example, there remains an effective head of nearly two feet per mile, and in a great majority of cases more than five feet per mile, for delivering the water upon the tops of the houses. And it may safely be inferred therefore, that the reservoir in either of the positions, and with the head above specified, is competent to deliver the water, without any extraneous aid upon the roof of every building in the City.*

*The writer cannot help noticing in this connection, the waste of power which occurs almost daily in the City of New-York, by reason of the application of human strength, in raising water for the extinguishment of fires, and which of course will cease to be necessary after the water is supplied in the manner described. A calculation on this subject was made, when the roof of the City Hotel was burnt sometime since, by which it was ascertained from the number of men employed, and the duration of the fire, that the amount of mechanic force expended in working the engines, was sufficient to have raised the whole material of the edifice from the street, to its appropriate position in the building. The like calculation applied to

Examination of other routes suitable for the use of iron pipes (in part.)

In all the preceeding discussions, relative to the location of the conduit, it will be seen, that the prevailing idea in the mind of the writer, has been, that, of a regular uninterrupted grade, from the fountain reservoir at Garretson's Falls, to the distributing reservoir in New-York. The next subject in order, would be to discuss the construction of the channel-way adapted to such a grade. But before doing so I would notice briefly, the different plans which have been discussed, and estimated with a view of ameliorating the expenses of the constructions at Harlaem River and elsewhere, on the location between that point and the distributing reservoir, by the substitution of iron pipes.

viz. that by the 8th Avenue.

The first plan of this kind begins with a slight increase of height at the Croton dam; and from thence to Harlaem River, is graded with a declivity of only 8 inches per mile, the channel-way being enlarged in due proportion for this purpose. This arrangement enables us to reach a recipient reservoir, (delineated on the map) in an elevated position near McComb's dam, with a head of 134½ feet above tide; and the distance from this point, by the 8th Avenue to Murray's Hill, being only 6½ miles, the idea was to lay down pipes on this distance, with a head of 3 feet per mile, and then deliver the water directly into the distributing reservoir at the latter place. There was reason to believe that this plan would compare advantageously with the location above described. It cut off nearly a mile of distance, and avoided the two heaviest aqueducts, and several of the most expensive miles on the route. And it was not till it had been estimated in

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other cases, and generally to all the fires that occur in the course of a year, gives an aggregate of moving power thus appropriated, which if it were employed in the movement of productive machinery, would be sufficient to drive at least two hundred power looms 12 hours per day, the year round. This calculation of course relates merely to the amount of power expended, without regard to the efficiency or inefficiency of its application, the security of property and life dependent thereupon, or any of the evils connected with the mode and manner of its use. These considerations being not strictly relevant to the object ofthis report.

all its details (Appendix 4) that this expectation was abandoned. It was found in consequence of the great expense of the pipes, and the enhanced cost of grading and channel-way, from the Croton to Harlaem River, that it would save nothing in this respect, while its capacity would be disadvantageously limited by the caliber of the pipes. No. successful.

The items of additional cost incurred by the arrangement amounted to,	$1,432,939 73
Those saved, ...	1,406,302 10
Difference against it, . . .	$26,637 63

A second plan for the same purpose, was to lead the water into the recipient reservoir as in the last arrangement, and thence to take it by pipes across McComb's dam, and along the foot of the hills, $2\frac{3}{8}$ miles, to a small effluent reservoir on the heights near the Lunatic Asylum, from which it could be conducted by a conduit on the ground of the previous location to the distributing reservoir. The same kind of result, however, was experienced in this case as in the former. The limitation of capacity was not as great indeed, there being a greater amount of disposable fall, but the comparison of expense was rather more unfavorable than in that case, viz: Modification of this route by the Lunatic Asylum. Not successful.

Items incurred.	$854,014 73
" saved, ...	788,840 35
Difference against the arrangement,	$65,174 38

The third plan for this purpose is a mere variation of detail from the scheme of the graded line, viz: the substitution of inverted syphons, in place of aqueducts, at the crossings of Harlaem River and the Manhattanville Valley. In a general case, not subject to any particular extraneous conditions, this substitution would be a matter of no difficulty or uncertainty whatever. A comparative estimate of the two structures would decide the whole question at once. The present case, however, it will be Modification of the grade plan by substitution of syphons.

seen, is not precisely one of this kind. The water is to be taken from a certain height on the Croton, determined by the minimum of expense, and delivered at a certain other determinate height in New-York; the quantity being also assumed. These circumstance becomes the data therefore of the general question. How can the given fall be distributed on the ground, in such a manner, as to deliver the quantity of water at the required point in New-York with the least expense. For example, in the graded line above described, we have supposed a regular declivity of one foot per mile. Should a mode of construction, however, be adopted on a single mile, which would require a fall of 10 feet to give it efficiency, it would be necessary to borrow 9 feet from the residue of the line, this would require a proportionate increase of water-way, and of course a more expensive structure on the whole line. It will be remarked that our channel-way, being an expensive structure of masonry, gives to such considerations more weight than is usual in ordinary cases. The fact will be made very obvious by comparing the estimates of the two lines, from the Croton River reservoir to Harlaem River, one graded at 12, and the other at 8 inches per mile; we thus find in a distance of 33 miles a difference of no less than $301,900 in the aggregate cost of the structure, (conduit included) which if the like variation were extended to the whole line, would give a total increase of $381,300, or $95,335 for each inch diminution of grade per mile.

The structure of the syphon itself would consist of the following particulars, viz.—First, (regarding that at the crossing of Harlaem River,) a bridge 880 feet long, in 23 feet water. Second, an influent and effluent reservoir. Third, a covert way of brick along the line of the

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The field operations, upon which, in connection with the examinations of the preceding year, the foregoing observations are founded, were commenced in the valley of the Croton on the 21st of October, and ended on the side of the distributing reservoir on the 13th December. Wm. Beckwith principal Assistant, Wm. H. Sidell second do. Oliver Smith, J. K. Nelson, J. G. Taylor, E. M. Taylor and L. F. Douglass attaches.

syphon and, finally, the pipes themselves. The last and most essential part of the construction has been calculated in a variety of modes—with pipes varying in size from two to five feet, and of various numbers, and head of water, accordingly. The larger size have the advantage of less friction, and, consequently, a greater discharge of water for each pipe under a given head. But they have, at the same time, the important practical disadvantage, of a greatly diminished strength and security, under the pressure to which they are exposed; and it appears that in compensating this by additional weight of metal, the expense, after a certain limit of size, becomes greater than in using an increased number of pipes of smaller calibre. My conclusion upon the whole is, that for the purpose now in view, pipes (of cast iron,)* 36 inches in diameter, have really no advantage over those of 30 inches, and it is even doubtful whether those of 27 or 28 inches diameter, may not be slightly preferable to either. I have, however, adopted the size of 30 inches, and the next consideration, is the number of pipes, and the head of water necessary for their efficient operation; and here, of course, we must regard the capacity of the conduit as the criterion for determining that of the syphon. It would be inexpedient probably. on the score of safety, to use fewer than two pipes, under any circumstances, which on a length of 506 yards, (the length of Harlaem syphon,) would require a head of 61 inches, or 57½ inches more than would be requisite for a simple conduit. This 57½ inches, according to the principle just stated, is to be borrowed from the residue of the line, making a diminution of 1·4 inches per mile, and the estimate, therefore, involving this consideration, will be as follows, viz:

* In drawing up my last year's report, I made some calculations upon the use of wrought iron mains, of four and five feet diameter, constructed in the manner of steam boilers, and counted upon this kind of main, as the connecting link between the receiving and distributing reservoirs of that report; but upon subsequent investigation, I am satisfied that the corrosion to which the material is liable, would be such as to render its use for this purpose very questionable, if not absolutely objectionable.

Bridge 880 feet long, 23 feet water, .	$205,060
Influent and effluent reservoir, . .	36,000
Pipes, double 30-inch main culvert included, 506 yards at $94 50 per yard, . .	47,807
	288,867
1 4-10 inch per mile difference of grade on 41 miles, 05·335 per inch, . . .	133,469
Total effective cost of a syphon of two 30-inch pipes, ...	$ 422,336

The calculation of three pipes would reduce the diminution of grade to 29 inches, or 7-10ths of an inch per mile, which would enter into the estimate, as follows, viz:

Bridge and reservoirs as before, .	$ 241,060 00
Triple pipe and culvert, 506 yards, at 125 dollars per yard, . . .	63,250 00
	304,310 00
Seven-tenths of an inch difference of grade on 41 miles, at 95·335 per inch, .	66,734 50
Total effective cost of a syphon of three 30-inch pipes, ...	$ 371,044 50
Four pipes, estimated in like manner, give an aggregate of . . .	$ 364,280 00

But beyond this, no further economy is effected by increasing the number comprising this amount, therefore, with the cost of an aqueduct, as estimated, ($415,650,) it shows a balance of 51,370 dollars in favor of the syphon construction at this place.

The like calculation applied to the Manhattanville Valley, stands as follows, viz:

Influent and effluent reservoir, . . .	$36,000 00
970 yards of syphon, consisting of 4 pipes and culvert, at $158 50 per yard, .	153,735 00
8-10ths of an inch per mile, difference of grade at 95·335 per inch, . .	76,268 00
Total syphon construction,	$ 266,003 00

Being a difference, in this case, of $60,652 against the syphon.

I now proceed to discuss, more particularly, the details of the channel-way for conducting the water. Four different modes of executing this most important part of the construction, have been spoken of at different times, viz: *Details of the conduit.*

1. A plain channel, without protection walls, constructed somewhat in the manner of an ordinary canal feeder. *Different modes of construction.*

2. An open channel, protected against the action of the current by masonry, of some kind.

3. An arched culvert, composed essentially of masonry. And

4. Iron pipes. (This method, however, having been just discussed, in regard to its particular application, and also, in my former report, as a system for general use, need not be further noticed in what follows.)* *Iron pipes not necessary to be further discussed.*

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* It was shown, in the former report,

1. That the structure of masonry adapted to the fall of 15 inches per mile, would cost about six thousand dollars less than the estimated expense of laying down a single iron main, 30 inches in diameter.

2. That considering the wear and tear of friction, and other incidental actions, operated by a volume of water, amountiug to 700 tons in a mile of pipe, moving rapidly under a pressure of 60lbs. to the inch, it was highly improbable that the iron mains would be as durable as the graded conduit; in which the water runs by mere declivity, with a very slight pressure, and a friction scarcely appreciable.

3. That a single 30-inch main, with the fall of 15 inches to the mile, would only deliver three millions of gallons daily, and that fewer than four such pipes, therefore, would not be sufficient to meet the anticipated demand, at the time of completing the works. Furthermore, that if a declivity should be adopted, such as to bring the required supply within the compass of two pipes, the aggregate fall would be such as to absorb the whole original head of 175 feet at the Muscoot dam, and carry the point of delivery 17 feet below the surface of the Hudson.

4. That, as the demand of the City increased, it would be necessary (with the 15 inches fall) to lay down pipes in addition to the four just mentioned, (each one at an expense exceeding that of a masonry channel,) and this so frequently, that a corps of mechanics would scarcely be dismissed, from one job, before it would be necessary to commence another.

In view of these considerations, some of which are increased in value,

1. Open channel without protection walls.

The consideration of these various modes should have reference, in the first place, to their efficiency for conducting the water in purity, and in the quantity required. Secondly, to their permanency as structures; and, thirdly, to their cost. And these circumstances, therefore, will constitute the chief grounds of the discussions and comparisons which follow.

1st. The plain channel without protection walls.

Of the efficiency of this mode of construction, so far as it depends merely upon form and dimensions, there can be no doubt. The nature of the work imposes no limits, in these respects, which could interfere with any measure of (geometrical) capacity that might be required. The objections to this species of channel, for the objects now contemplated, are of a more practical kind, as will be seen.

It has been frequently noticed, by those engaged extensively in the construction of public works, that no channels (other things being equal) are so difficult to make and keep tight as feeders; and the reason is sufficiently obvious, although, in some instances, it has not been rightly appreciated. Most artificial channels of earth or gravel, when first constructed, are, in some degree, pervious to water. In process of time, however, the water itself moving gently through them, and, having, as is commonly the case, a small proportion of clay in suspension, operates as a styptic, by depositing the latter in the pores of the channel, and thus rendering them tight. But if the water moves with too great velocity, this effect cannot take place; and with a high degree of acceleration, it not only retains the styptic material, previously suspended, but actually sweeps away, by the force of the current, the artificial substitute which the caution of the Engineer may have supplied.

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by the change from 15 to 12 inches fall, it is very safe to infer, that the channel of masonry is at once the cheapest, the most durable, and the most effectual.

Objections to this mode

The laws of this action have been deduced experimentally, and found to be as follows, viz:—a velocity of three inches per seond, begins to work upon fine clay; that of 6 inches, upon fine sand; that of 8 inches, upon sand as large as linseed; 12 inches, upon small gravel; 2 feet, upon rounded pebbles the size of an inch, and 3 feet, upon stones as large as an egg.* Now the actual velocity of a stream, either at the surface, at the bottom, or at a mean, is in a certain relation to its transverse section and fall; and with a knowledge of these relations we may infer one or another of these velocities in any given case. In that before us, it is demonstrable, that with any arrangement of profiles, suited to the nature and object of the work, the velocity of the current in contact with the bottom, will not be less than twelve inches per second, which is sufficient, it seems, to move small gravel.

The evil consequences of such an action upon a conduit, situated as this would be, almost wholly upon bold sideling ground, would be two-fold,—first, the filtration and irretrievable loss of a large proportion of the water; and, secondly, the imminent danger of the banks themselves being carried away, whenever the head of water should be increased, and the banks softened by the long continuance of heavy rains. Neither of these evils are of any consideration, in ordinary cases, compared with their importance in this. The filtration of a hundred cubic feet of water per mile, per minute, is frequently counted upon as one of the regular wants of a canal, and provided for accordingly; but at this rate, (and, I presume, under the circumstances mentioned, it would not be less,) forty miles of filtration would absorb upwards of forty-three millions of gallons per day.

Again,—the failure of a canal bank, of which we hear instances, more or less, every year, is a very trifling event, estimated by a few weeks interruption to a canal trade, compared with the suspension of the supply of

* Robison's Mechanical Phi. vol. 2.

Deemed conclusive.

water to this metropolis, for even a single day. Canals, moreover, have seasons of periodical suspension, when they may be thoroughly repaired and put in order, without any interruption to the navigation; but the City Aqueduct, when once put in operation, must flow unceasingly in winter as well as summer, and from year to year. Any deficiency in its performance, at any time beyond the competency of its reservoirs to supply, would be regarded as a public calamity; and any mode of construction, therefore, involving the contingency of such a suspension, is, in the view of the undersigned, decidedly objectionable. Many other considerations might be adduced on this point, but, I trust, those here given, will be sufficient to show the practical unfitness of this method of construction, for a work of the nature and objects of that contemplated.

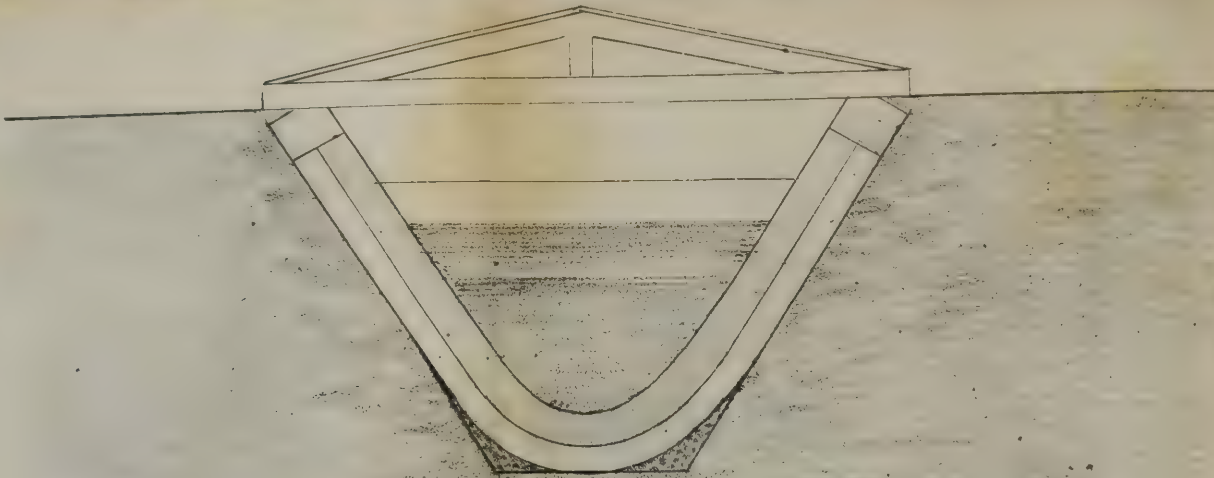
2. Open channel with protection or slope walls.

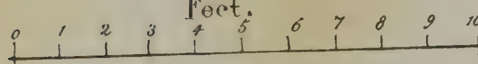
2d. An open channel, protected against the wash of the current, by masonry of some kind. There are two modes of applying masonry for protecting the interior of a channel of the kind here supposed. First, by regular side walls, with or without a reversed arch at bottom. Secondly, by slope walls laid up with an inclination corresponding to that of the bank on which they rest. The first kind are much the most massive, being necessarily proportioned in strength to the pressure of the earth behind them, while the second recline upon the face of the bank, and are supported by it, merely protecting its surface from the action of the water. The most feasible arrangement of the latter method, for the purpose now in view, is believed to be that represented (with different dimensions) in the annexed diagrams No. 1 and 2, consisting of a narrow reversed arch and slope walls of brick, the whole resting upon a layer of beton or concrete, six inches in thickness.

Details of this arrangement.

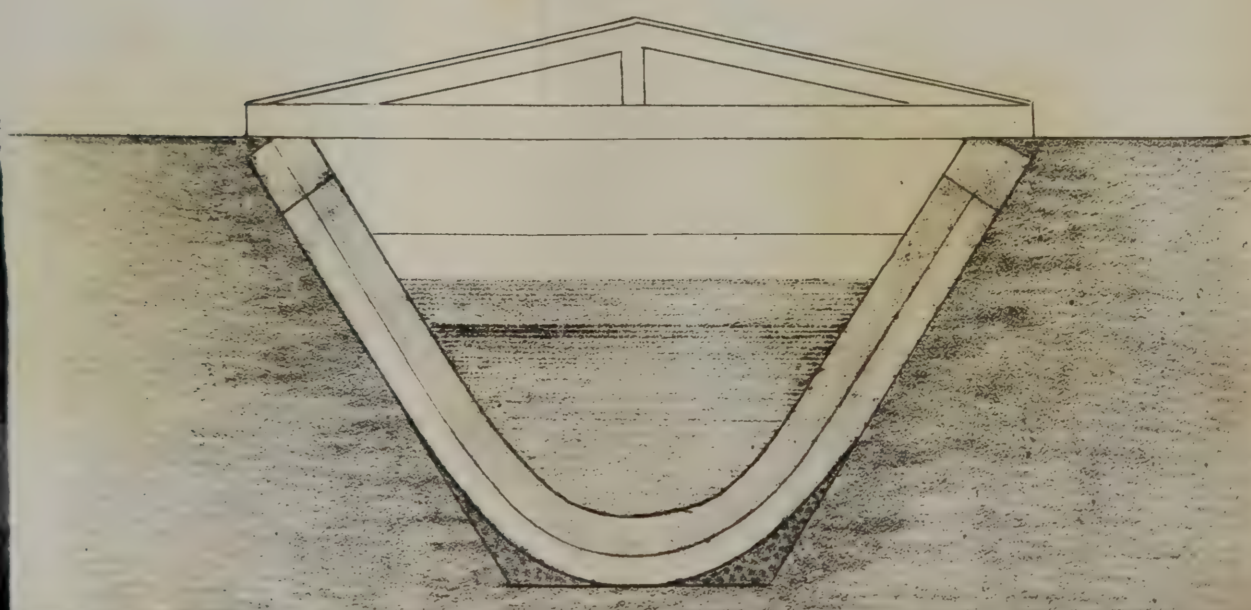
The sectional area of masonry for this profile, in the case of No. 1, is $27\frac{1}{2}$ square feet (including the beton), and the sectional area of its water-way, at the level of the upper line, $28\frac{1}{2}$ feet. A channel of equal capacity, constructed with regular side walls, as first mentioned,

N. 1.





N.º 2.



would contain, at least, 44 square feet sectional area of masonry; and its cost, allowing all the advantage it would gain, from the circumstance of stone masonry being less expensive than brick, would be to that of the profile just described, in the ratio of at least 10 to 7. There can be no doubt, therefore, that for all the purposes of an open channel, the slope wall profile is altogether the preferable structure.

Slope walls preferable.

The example No. 1, is adapted to a fall of one foot per mile, and gives with that fall the following discharges, viz:

Example, No. 1.

At the lower line, being 3 ft. deep in the middle, .	11,404,544	gals. per min.
At the second, 4 feet deep,	20,088,100	"
At the third, or upper ditto, 5 feet	31,104,000	"

Capacity.

The sectional area of the masonry of this profile, as just stated, is $27\frac{1}{2}$ feet, of which $12\frac{1}{2}$ feet are brick work laid in cement, and the remaining 15 feet, beton and stone work, and the cost of the construction per mile, therefore, estimated from these dimensions, independently of grading, will be as follows:

Estimate.

Preparing bottom and slopes, at 50 cents per yard, ...	$ 880 00
$(12\frac{1}{2} \times 5280) = 66{,}000$ cubic feet of brick work laid in cement, at 30 cents per yd.	19,800 00
$(15 \times 5280) = 79{,}200$ cubic feet beton and stone work, at 18 cents per yard, .	14,256 00
Coping extra=10,560 running feet, at 15 cents per foot, ...	1,584 00
Total per mile,	$ 36,520 00

The profile No. 2, is adapted to the fall of 8 inches per mile, and will deliver, with that descent, and at the respective depths before mentioned, as follows, viz:

Example, No. 2.

At 3 feet deep, .	10,491,120	gal. per diem
At 4 feet deep, .	19,274,760	"
At 5 feet deep, .	30,119,035	"

Capacity.

The sectional area of its masonry is 33 square feet, of which 15 are brick, and the residue beton and stone, and its cost, per mile, is accordingly estimated as follows, viz:

Estimate.

Preparing the bottom and slopes, at 60 cents per yard, run.	$1,056 00
79,200 cubic feet brick work in cement, at 30 cents per yard, ...	23,760 00
95,040 cubic feet beton and stone work, at 18 cents per yard, ...	17,107 20
Coping extra, 10,560 feet, at 15 cents per yard, ...	1,584 00
Total per mile,	$43,507 20

Objections,

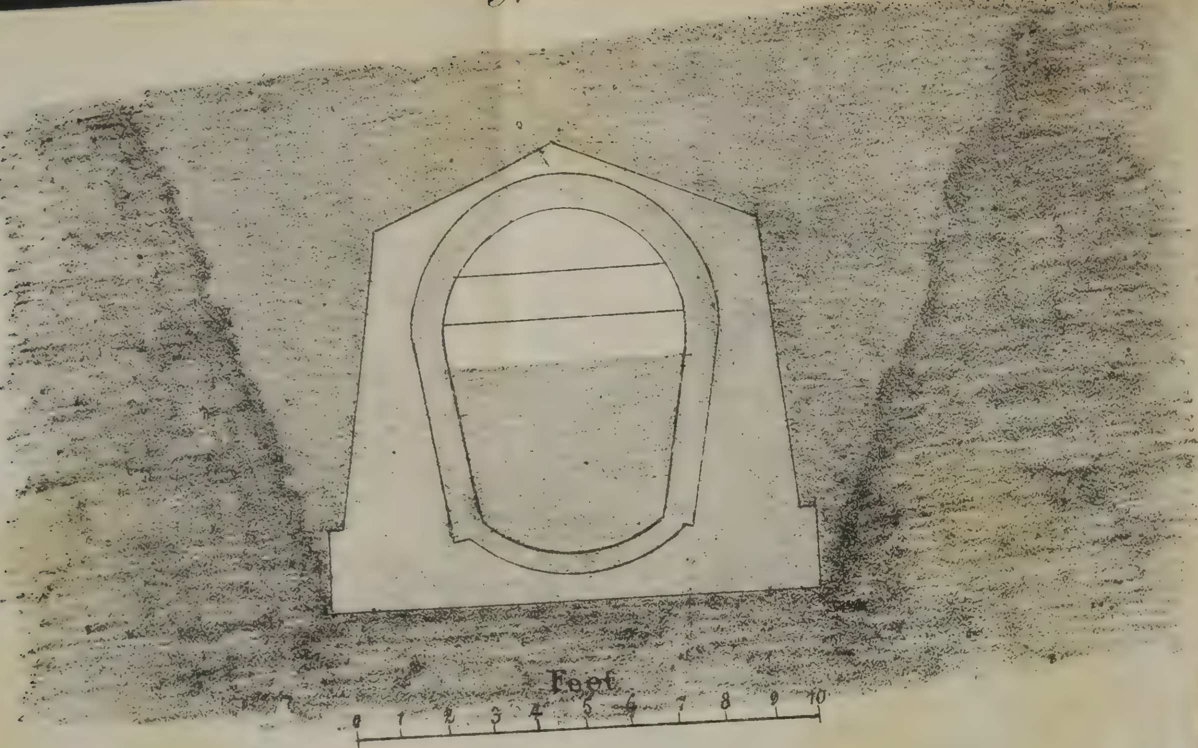
The only objections to these profiles, are such as apply equally to every species of open channel; first, that they are exposed in many situations to receive the wash of the country through which they pass; and, secondly, that they are unprotected from the frost, and (possibly) liable to be interrupted thereby. The first of these objections may be obviated in all situations, where it would be advisable to use these modes of construction, by means of back drains, for which, therefore, I have made provision in the estimates. With regard to the second, although the probability of the event is remote, it is possible that the concurrence of heavy snow-drifts and severe frost might, if the channel is left altogether without protection, produce an occasional interruption. The plantation of trees and shrubbery of proper kinds, would probably afford some protection; but the more effectual safeguard would be to close the channel entirely, by means of a light roof, of which a profile is sketched in the diagrams annexed. The cost of such an addition, covered merely with planks, tongued, grooved and sanded, would be for the smaller channel, 7,100 dollars per mile, and for the greater, 8,960 dollars, making aggregates, in the first case, $43,620; and in the second, $52,467 20.

Oviated by the construction of a roof.

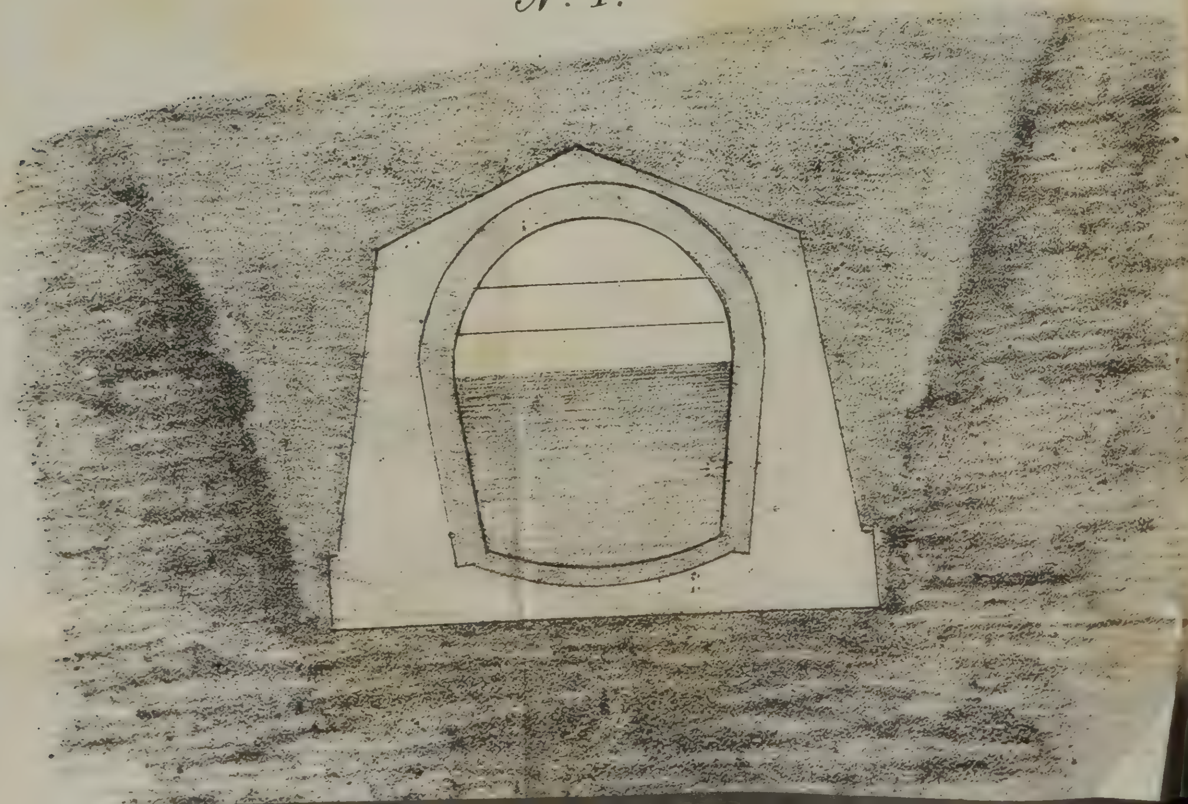
3. Arched channel.

3d. A close channel or culvert, composed essentially of masonry.

N.° 3.



N.° 4.



The annexed diagrams, No. 3 and 4, are examples of this mode of construction. The first adapted to the fall of one foot per mile, and the other, to that of eight inches, and calculated, with these respective declivities, to discharge from ten to thirty millions of gallons daily, at depths varying from three to six feet. They are arranged, as to their interior and exterior outline, with a view to insure the greatest degree of strength and stability, with the smallest amount of material. The sectional area of masonry in No. 3, is $53\frac{1}{2}$ square feet; that of No. 4, $57\frac{1}{2}$ square feet. This, in either case, may be constructed entirely of brick, or with an interior facing of brick, and backing of stone, or with an arch of brick, and the whole residue of stone. And the choice of one or other of these modes is to be determined chiefly by the estimate. Good rough stone masonry, laid in common lime, is estimated by builders in New-York, at 16 to 18 cents per cubic foot; hammer dressed stone at 25 cents. The first kind, on the line of the aqueduct, and with due regard to the quality which should prevail, in a work of this kind, is estimated at 18 cents, and at $20\frac{1}{2}$ cents laid in good American hydraulic cement. An average quality of cemented wall, however, may be produced, suitable for backing, at 19 cents. For brickwork, the New-York estimates are as follows, viz:

Different modes of construction.

In party walls with joints, rough,	24 cts.	per cubic foot.	
In external walls, with smooth joints, ...	26	ditto	ditto.
In arches and vaults, . .	27	ditto	ditto.

Estimated comparativety.

By a close analysis, these sums might be reduced, probably, two cents per foot, making the work in arches and vaults, 25 cents; and that suitable for backing, 22 cents; the whole being laid, however, in common lime. Using hydraulic cement, the cost is found to be 29 81-100, say 30 cents per foot, (or \$16 40 per thousand bricks,) for face work, and say 24 cents for backing. We may now apply these elements to the estimate of No. 3, viz:

1st. The structure entirely of brick.

14½	sectional feet, face work and arches, in cement, at 30 cents,	4 35
39	ditto backing, partially cemented, 24 cts.	9 36
	Total per foot, run.	$13 71

2d. Lining of brick and backing of stone.

14½	sectional feet, face, &c. as before, at 30 cents,	4 35
39½	ditto backing of stone, at 19 cents,	7 41
	Total per foot, run.	$11 76

3d. Arches of brick, and the residue of stone, viz:

9	sectional feet (brick work) vaulting, at 30 cents	2 70
8½	ditto hammered stone facing in cement, at 27 cents,	2 29½
36	ditto stone back, at 19 cents,	6 84
	Total per foot, run.	11 83½

Conclusion.

By the comparison of these estimates, it appears that the structure, composed entirely of brick, (which, on other accounts would have been desirable,) will cost nearly two dollars per running foot, (upwards of 10,000 dollars per mile,) more than either of the others. The two modes of combining stone and brick, appear to differ very little from each other, in point of cost, but as the cheaper is calculated also to facilitate the execution of the work, it is decidedly preferred.

Its construction is estimated from the running cost as follows, viz:

Estimate per mile for this structure.

5280 feet at $11 76 per foot=$62,092 80 per mile.

The estimate of No. 4, by the same scale of prices, will stand as follows, viz:

15½ sectional feet of brick work, at 30 cents,		$4 65
42 ditto ditto stone work, at 19 cents,		7 98
	Making, per running foot,	$12 63
	And per mile,	$66,686 40

It can scarcely be doubted, that these modes of constructing the channel-way, independently of first cost, are preferable to every other. They secure the water effectually against all incidental causes of impurity or turbidness, as well as from the possibility of its current ever being interrupted by the inclemency of winter; and they are, at the same time, decidedly superior in point of stability. In some situations, indeed, the culverted or close channel will be preferable, even on the score of economy, either in reference to the work itself, or to the country through which it passes; intersecting villages, for example, and in deep cuttings, where for any reason whatever, it would be desirable to fill the earth back over the arch. Situations of this kind are found on or about 13 miles of our line, and in estimating, therefore, under these different views, I have given one series of results for a channel-way, culverted throughout, and another, for a mixed construction, culverted on 13 miles, and slope walled on the residue, as in profile No, 1.

Its advantages.

Application of these modes to the graded line.

Description and Estimate of Grade-work.

Under the general denomination of grade-work, I include all the work of a local and particular character, occurring on the line, whether preparatory to the grade or otherwise. The construction of the dam and reservoir on the Croton: clearing the ground, excavations of rock or soil, drains, culverts, aqueducts, road-crossings, stone embankments, and lastly, the back filling and terraceings. The annexed itinerary and estimates furnish detailed calculations of all these items, from the fountain reservoir on the Croton, to the distributing reservoir on

Description and estimate of grade work.

Excavation.

Embankment.

Murray's Hill, including, also, the alternative of a termination at Bloomingdale square.

The preparation of the grade in excavation, whether of rock or soil, has nothing particular, except its form and dimensions, to distinguish it from ordinary grading on other public works. In embankments, however, it is proposed to construct the work somewhat differently, by forming as a foundation, immediately under the line of the conduit, (whether open or closed) a mound of solid stone, (as in the annexed profiles No. 6 and 8,) this material being found in sufficient abundance every where on the line, and forming in this way, as the writer has had occasion to experience in similar situations, a cheap and very safe foundation. The residue of the embankment after the conduit is built, is then to be formed to the necessary height and width, with good gravel or loam, on the slopes of which, in situations requiring enclosure, live hedges, of a proper kind, may be very profitably and tastefully cultivated.

Arcades of brick.

On the last two miles, where the relief of the grade line becomes in some places considerable, it was found that arcades of brick could be advantageously substituted for embankment, in certain situations, with a considerable saving of expense, and they have been estimated therefore accordingly.

Iron drains.

The drains of iron spoken of in the estimate, are merely iron water pipes, of proper sizes, laid through the embankment with wings of masonry, grouted into the masonry of the aqueduct, as the occasion requires. Larger drains and culverts are supposed to be constructed in the usual way with stone or brick, according to circumstances.

Remark on the Masonry generally.

Generally for all masonry, where rough or common hammered stone can be used, it is preferable, on the score of economy; but in many cases where cut stone or stone in large blocks would be desirable, brick is a valuable and economical substitute.

Aqueducts.

The lesser aqueducts, therefore, and that at Manhattanville, are generally estimated of this material.

The Harlaem aqueduct has been estimated in massive

stone masonry, and also in brick. The latter material is of course the cheaper in itself, but as it required smaller arches, it involved the construction of a greater number of piers and hydraulic foundations, and consequently gave a result differing but little from the estimate in stone.—See sketch No. 11 and 12.

Harlaem aqueduct.

In summing up the estimates, I have used the amount set down for this structure as an aqueduct, notwithstanding the slight difference estimated in favor of the syphon. My impression is, that the greater simplicity and certainty of action, in an uninterrupted channel, from the Croton to the distributing reservoir at Murray's Hill, will commend this arrangement to the Commissioners and the community; and it has been suggested also, that the interests of the public in this structure, as a bridge for connecting the heights of Harlaem, with those of West Chester, would more than countervail all differences of expense.

May be used as a Street Bridge.

The distributing reservoir is estimated of sufficient size for all purposes, surrounded by a wide rampart of earth and masonry, and divided into two apartments. Should a separate depurating reservoir be required, it may be constructed with great convenience in several positions, either on the West Chester heights or on the Island.

Distributing reservoir.

Under these various heads, two calculations have been made upon each mile of the route. One answering to the construction of a close channel, according to the profile No. 3, and the other for an open channel, according to No. 1; and in summing up the amounts, a result is also obtained for a mixed construction, consisting of a slope walled profile on 28 miles of the route, and a close conduit on the residue.

Manner of making the annexed calculations.

It only remains now, to collect the results of the various estimates in a summary view, as follows, viz:

General summary of the estimates.

For a mixed construction, terminating at Murray's Hill:

Itinerary estimate, 41 miles, .		$1,693,013 36
28 miles conduit, No. 1, as above, at $43,620 00,	$1,221,360 00	
13 miles conduit, No. 3, as above, at $62,092 80,	807,206 40	
		2,028,566 40
Nett cost according to the estimates,		$3,721,579 76
Administration, engineering, contingencies, &c. 10 pr cent,		372,157 97
Total, ...		4,093,737 73

For a culverted construction throughout, terminating at Murray's Hill:

Itinerary estimate 41 miles, . .	$1,682,593 29
41 miles culvert, at $62,092 80 per mile, ...	2,545,804 80
Nett cost by the estimates, . .	$4,228,398 09
Administration, engineering, contingencies, &c. 10 per cent. . .	422,839 81
Total, ...	$4,651,237, 90

The corresponding totals for the termination at Bloomingdale square, would be as follows, viz:

For the mixed construction, .	$3,791,810 33
And for the culverted construction entire, ...	4,349,310 50

Being a difference in each case, of 301,927 dollars; but taking into consideration, that all the City drains, in the case of the Bloomingdale location, would require an additional length of one mile and fourteen chains, the Murray's Hill location is deemed preferable.

Land and damages.

Estimate of land, damages, and water rights not included in the above, viz:

On the Croton, ...	$28,500
On the line, ...	36,900
Reservoir, ground, &c. in New-York,	70,000
Total, ...	$135,400

It is estimated that the work may be completed in four years from the time of actual commencement.

Time necessary for cnostructing the work.

All which is respectfully submitted.

D. B. DOUGLASS, *Civil Engineer.*

February 1*st*, 1835,

The above estimate for land and damages, includes the location for the reservoir on Murray's Hill; doubtless, however, the lands already owned by the Corporation, would answer for this purpose.

APPENDIX No. 1.—ITINERARY DESCRIPTION AND ESTIMATE

Of Grade Work, including Aqueducts, Culverts, Road Crossing, &c. &c. on the whole line.

DAM AND RESERVOIR at Garretson's Falls, 33 feet above the bed of the stream, or 154 feet above tide. Lip of the overfall 120 feet long. Abutments and curtain of solid masonry laid in cement—sheeted and filled in with gravel.

ITEMS OF WORK.	Estimate for a close channel.		For an open channel.	
Heavy stone masonry, viz:	48,540 cu ft at 30 cts	$14,562 00		
Coping, joggled and fastened down, .	1,200 sq ft at 45 cts	540 00		
Draw gate and culvert, ...		925 00		
Puddling and gravel filling, . . .	28,800 yds at 30 cts	8,640 00		
Timber work, sheeting, &c. . . .		1,150 00		
Fore bay, gate, house and gates, . .		1,800 00		
Forming reservoir banks, removing trees, &c.		4,500 00		
Reconstructing highway above and below dam,		1,500 00		
	Total. .	$33,617 00		$33,617 00

FIRST MILE—From the dam along the hill sides of the Croton—50 chains rocky.

ITEMS OF WORK.	Estimate for a close channel.		For an open channel.	
Grubbing and clearing ground, . .		$ 160 00		$160 00
Culverts, viz: 1–3 feet and 2 iron pipes,		520 00		675 00
Excavation, earth, ...	10,600 c yds at 15 cts	1,590 00	6,720 c yds at 15 cts	1.008 00
Excavation, rock, ...	18.520 " 80 cts	14,816 00	11,708 " 80 cts	9,366 40
Back filling, ...	9,500 " 10 cts	950 00	1,825 " 10 cts	482 50
	Total, .	$18,036 00		$11,691 90

SECOND MILE—South side slope Croton Valley, undulating, gravelly loam with boulders.

Grubbing and clearing ground, . .		$ 75 00		$ 75 00
Culverts, 2–3 ft. and 2 iron pipes, . .		820 00		1,000 00
Excavation, earth, ...	35,128 c yds at 15 cts	5,269 20	22,100 c yds at 15 cts	3.315 00
Excavation, rock, ...	2,115 c yds at 75 cts	1,586 25	1,350 c yds at 75 cts	1,012 50
Embankment, stone, ...			880 c yds at 50 cts	440 00
Back filling, ...	19,066 c yds at 10 cts	1,906 60	1,755 c yds at 10 cts	175 50
Road crossings, (2)		500 00		650 00
	Total, .	$10,157 05		$6.668 00

THIRD MILE—Hillside as before, gravelly loam with boulders.

ITEMS OF WORK.	Estimate for a close channel.		For an open channel.	
Grubbing and clearing ground,		$120 00		$ 120 00
Culverts, viz: 1–10 ft. chord, 2–3 ft. and 2 iron pipes,		1,796 00		2,410 00
Excavation, earth,	36,388 c yds at 15 cts	5,458 20	22,830 c yds at 15 cts	3,424 50
Excavation, rock,	860 " 75 cts	645 00	580 " 75 cts	435 00
Embankment, stone,	1,200 " 50 cts	600 00	2,588 " 50 cts	1,294 00
Back filling,	2,100 " 15 cts	315 00	3,660 " 15 cts	549 00
Back filling,	16,870 " 9 cts	1,518 30	8,545 " 9 cts	769 05
	Total,	$10,452 50		$9001 55

FOURTH MILE—Hillside as before, chiefly gravelly loam, with boulders.

Grubbing and clearing ground,		$350 00		$350 00
Culverts, viz: 2–3 feet and 3 iron pipes,		920 00		1,215 00
Excavation, earth,	38,480 c yds at 15 cts	5,772 00	24,050 c yds at 15 cts	3,607 50
Excavation, rock,	1,260 " 75 cts	945 00	975 " 75 cts	731 25
Back filling,	16,800 " 9 cts	1,512 00	10,230 " 9 cts	920 70
	Total,	$9,499 00		$6,824 45

FIFTH MILE—Hillside Croton Valley, 24 chains rock, slight extra cutting, residue gravelly loam, with boulders and loose rock.

ITEMS OF WORK.	Estimate for close channel.		For an open channel.	
Grubbing and clearing ground,		$ 275 00		$ 275 00
Culverts, viz: 2–5 ft and 3 iron pipes,		1,220 00		1,775 00
Excavation, earth,	24,620 c yds at 15 cts	3,693 00	15,480 c yds at 15 cts	2,322 00
Excavation, rock,	8,800 " 80 cts	7,040 00	5,610 c yds at 80 cts	4,488 00
Back filling,	14,784 " 9 cts	1,330 56	10,860 c yds at 9 cts	977 40
Road crossing, (2)		680 00		825 00
	Total,	$14,238 56		$10.662 40

SIXTH MILE—Hillside as before, termitting in the tunnel at the mouth of the Croton, one quarter rock.

Grubbing and clearing ground,		$275 00		$275 00
Culverts, viz: 1–5 ft. 1–3 ft. and 2 iron pipes,		1,660 00		1,170 00
Excavation, earth,	31,586 c yds at 15 cts	4,739 90	20,034 c yds at 15 cts	3,005 10
Excavation, rock,	2,232 " 80 cts	1,785 60	1,410 " 80 cts	1,128 00
Embankment, stone	920 " 50 cts	460 00	2,120 " 50 cts	1,060 00
Back filling,	17,560 " 9 cts	1,580 40	8,875 " 9 cts	798 75
Back filling,	2,100 " 15 cts	315 00	3,915 " 15 cts	587 25
Road crossing,		325 00		380 00
		$10,540 90		$8,404 10

TUNNEL through Tompkins Hill, 287 yards rock, drift way 7 square yards.

Drift Cutting,	2,009 c yds at $5	$10,045 00		$10,045 00

SEVENTH MILE—Hillside between mouth of Croton and Sing Sing, very undulating.

ITEMS OF WORK.	Estimate for a close channel.		For an open channel.	
Grubbing and clearing ground,		100 00		100 00
Culverts 1–20 ft. with wings and embankments,		3,638 00		4,750 00
Culverts, 1–5 ft. 2–3 ft. and 3 iron pipes,		1,350 00		1,755 00
Excavation, earth,	12,550 c yds at 15 cts	1,882 50	7,920 c yds at 15 cts	1,188 00
Excavation, rock,	6,992 c yds at 80 cts	5,593 60	4,382 c yds at 80 cts	3,505 60
Embankment, stone,	8,262 c yds at 50 cts	4.131 00	11,422 c yds at 50 cts	5,711 00
Back filling,	8,620 c yds at 15 cts	1 293 00	11,980 c yds at 15 cts	1,797 00
Back filling,	11,200 c yds at 9 cts	1,008 00	13,610 c yds at 9 cts	1,224 90
Road Crossing,		350 00		475 00
	Total,	$19,346 10		$20,506 50

EIGHTH MILE—Undulating Hillside above Sing Sing—Excavation nearly one third rock.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground, ...		$ 100 00		$ 100 00
Culverts, viz: 1–3 ft and 4 iron pipes, .		720 00		885 00
Excavation, earth, ...	19,523 cu yds at 15 cts	2,928 45	12,430 cu yd at 15 cts	1,864 50
Excavation, rock, ...	12,056 " 100	12,056 00	7,600 " 100	7,600 00
Embankment stone, ...	3,792 " 50	1,896 00	6,224 " 50	3,112 00
Back filling, ...	5,720 " 15	858 00	6,820 " 15	1,023 00
Back filling, ...	10,856 " 9	977 04	9,566 " 9	860 94
	Total, .	$19,535 49		$15,445 44
Kill Brook Aqueduct, 140 feet, with abutments, &c. . . .		$13,450 00		$13,450 00

NINTH MILE—Sing Sing deep cut and tunnel, 25 chains.

Grubbing and clearing ground, . . .		$ 50 00		$ 50 00
Culvert, viz: 1–5 ft		630 00		630 00
Excavation, earth, ...	29,100 cu yd at $12\frac{1}{2}$ ct	3,637 50	29,100 cu yd at $12\frac{1}{2}$ ct	3,637 50
Excavation, rock, ...	10,780 " 80	8,624 00	10,780 " 80	8,624 00
Drift cutting in tunnel, ...	3,850 " $5	19,250 00	3,850 " $5	19,250 00
Embankment stone, ...	6,850 " 50	3,425 00	8,320 " 50	4,160 00
Back filling, ...	6,600 " 15	990 00	10,500 " 15	1,575 00
Back filling, ...	24,620 " 9	2,215 80	24,620 " 9	2,215 80
Road crossing, T. P.		300 00		420 00
	Total, .	$39,122 30		$40,562 30

TENTH MILE—Sideling ground below Sing Sing—generally fair—occasionally rocky.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground, . . .		$ 250 00		$ 250 00
Culverts, viz: 1-10 ft and 2 iron pipes, .		1,646 00		2,298 00
Excavation, earth, ...	32,880 cu yd at 12½ ct	4,110 00	20,550 cu yd at 12½ ct	2,568 75
Excavation, rock, ...	2,080 " 75	1,560 00	1,300 " 75	975 00
Back filling, ...	13,680 " 10	1,368 00	8,830 " 10	883 00
	Total, .	$8,934 00		$6,974 75

ELEVENTH MILE—Sideling ground continued—slightly undulating.

Grubbing and clearing ground, . . .		$ 100 00		$ 100 00
Culverts, viz: 1–5 ft and 2 iron pipes, .		786 00		1,205 00
Excavation, earth, ...	33,120 cu yd at 12½ ct	4,140 00	20,730 cu yd at 12½ ct	2,591 25
Excavation, rock, ...	1,830 " 75	1,372 50	1,230 " 75	922 50
Back filling, ...	11,450 " 10	1,145 00	8,366 " 10	836 60
Road crossing, T. P.		300 00		450 00
	Total, .	$7,843 50		$6,105 35

TWELFTH MILE—Sideling ground as above—Excavation one quarter in rock.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$ 100 00		$ 100 00
Culverts, viz: 1–3 ft and 2 iron pipes,		500 00		725 00
Excavation, earth,	16,180 cu yd at 12½ ct	2,022 50	10,115 cu yd at 12½ ct	1,264 37
Excavation, rock,	4,220 " 80	3,376 00	2.630 " 80	2,104 00
Back filling,	14,212 " 10	1,421 20	35,100 " 12½	4,387 50
	Total,	$7,419 70		$8,580 87

THIRTEENTH MILE—Approaching and crossing Sleepy Hollow—10 chains deep cutting in rock, estimated as a tunnel—excavation, one quarter in rock.

Grubbing and clearing ground,		$ 150 00		$ 150 00
Culverts, viz: 1–3 ft and 1 iron pipe,		520 00		645 00
Excavation, earth,	12,504 cu yd at 12½ ct	1,563 00	7,815 cu yd at 12½ ct	976 87
Excavation, rock,	4,786 " 80	3,828 80	2,990 " 80	2,392 00
Drift cutting,	1,540 " $5	7,700 00		7,700 00
Embankment stone,	4,250 " 50	2,125 00	6,280 " 50	3,140 00
Back filling,	8,140 " 15	1,221 00	9,280 " 15	1,392 00
Back filling,	11,258 " 9	1,013 22	19,510 " 9	1,755 90
	Total,	$18,121 02		$18,151 77
Sleepy Hollow Aqueduct, 480 ft long,		$69,840 00		$69,840 00

FOURTEENTH MILE—Undulating Side Hill, above Tarrytown—say one fifth rock.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$ 150 00		$ 150 00
Culverts, viz: 1–3 ft and 2 iron pipes,		610 00		760 00
Excavation, earth,	18,200 cu yd at $12\frac{1}{2}$ ct	2,275 00	11,440 cu yd at $12\frac{1}{2}$ ct	1,430 00
Excavation, rock,	3,960 " 80	3,168 00	2,500 " 80	2,000 00
Back filling,	14,460 " 10	1,446 00	16,530 " 10	1,653 00
	Total,	$7,649 00		$5,993 00

FIFTEENTH MILE—Passing Tarrytown, on Side Hill, one fifth rock.

Grubbing and clearing ground,		$ 180 00		$ 180 00
Culverts, viz: 1–5 ft 1–3 ft and 2 iron pipes,		1,010 00		1,275 00
Excavation of earth,	17,920 cu yd at $12\frac{1}{2}$ ct	2,240 00	11,220 cu yd at $12\frac{1}{2}$ ct	1,402 50
Excavation of rock,	4,360 " 80	3,488 00	2,725 " 80	2,180 00
Back filling,	13,740 " 10	1,374 00	15,308 " 10	1,530 80
Road crossings, (2)		660 00		880 00
	Total,	$10,952 00		$7,448 30

SIXTEENTH MILE—Undulating Side Hill, below Tarrytown, say one quarter rock.

ITEMS OT WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$ 80 00		$ 80 00
Culverts, viz: 1–10 ft wings and shoreing 1–3 ft and 2 iron pipes,		1,936 00		2,540 00
Excavation of earth,	17,714 cu yd at 12½ ct	2,214 25	13,287 cu yd at 12½ ct	1,660 87
Excavation of rock,	3,320 " 80	2,656 00	2,490 " 80	1,992 00
Embankment stone,	7,100 " 50	3,550 00	10,550 " 50	5,275 00
Back filling,	9,712 " 15	1,456 80	13,875 " 15	2,081 25
Back filling,	7,696 " 9	692 64	2,820 " 9	253 80
Road crossings, (2)		680 00		8 0 00
	Total,	$13,265 69		$14,762 92

SEVENTEENTH MILE—Below Tarrytown, somewhat undulating.

Grubbing and clearing ground,		$ 50 00		$ 50 00
Culverts, viz: 1–5 ft and 3 iron pipes,		710 00		1,050 00
Excavation of earth,	21,634 cu yd at 12½ ct	2,704 25	15,890 cu yd at 12½ ct	1,986 25
Excavation of rock,	4,235 " 80	3,388 00	3,080 " 80	2,464 00
Embankment stone,	264 " 50	132 00	930 " 50	465 00
Back filling,	2,120 " 15	318 00	3,045 " 15	456 75
Back filling,	18,428 " 9	1,658 52	23,650 " 9	2.128 50
	Total,	$8,960 77		$8,600 50

EIGHTEENTH MILE—Undulating Side Hill, between Tarrytown and Greensburg.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$ 50 00		$ 50 00
Culverts, viz ; 1–5 ft 2–3 ft and 2 iron pipes,		3,230 00		4,140 00
Excavation of earth,	23,875 cu yd at 15 cts	3,581 25	16,220 cu yd at 15 cts	2,433 00
Embankment stone,	5,456 " 50	2,728 00	7,756 " 50	3,878 00
Back filling,	4,400 " 15	660 00	4,875 " 15	731 25
Back filling,	9,488 " 9	853 92	8,220 " 9	739 80
Road crossing,		375 00		460 00
	Total.	$11,478 17		$12,432 05

NINETEENTH MILE—Above Greensburg—undulating—heavy embankment at Jewel's Brook.

Grubbing and clearing ground,		50 00		50 00
Culverts, viz : 1–20 ft and 1 iron pipe,		3,448 00		4,550 00
Excavation of earth,	24,292 cu yd at 12½ ct	3,036 50	17,180 cu yd at 12½ ct	2,147 50
Embankment stone,	12,000 " 60	7,200 00	16,860 " 60	10,116 00
Back filling,	10,940 " 15	1,641 00	12,240 " 15	1,836 00
Back filling,	8,764 " 9	788 76	4,855 " 9	436 95
Road crossings,		375 00		475 00
	Total,	$16,539 26		$19,611 45

TWENTIETH MILE—Passing Greensburg—heavy embankments crossing the ravine.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$ 250 00		$ 250 00
Culverts, viz: 1–10 ft 1–5 ft 1–3 ft		2,110 00		2,550 00
Excavation, earth,	21,734 cu yd at 12½ ct	2,716 75	14,760 cu yd at 12½ ct	1,845 00
Excavation, rock,	1,200 " 75	900 00	875 " 75	656 25
Embankment stone,	6,252 " 50	3,126 00	9,550 " 50	4,775 00
Back filling,	8,620 " 15	1,293 00	10,140 " 15	1,521 00
Back filling,	19,130 " 9	1,721 70	17,770 " 9	1,599 30
Road crossing,		650 00		800 00
	Total,	$12,767 45		$13,996 55

TWENTY-FIRST MILE—Below Greensburg—undulating.

Grubbing and clearing ground,		100 00		100 00
Culverts, viz: 3–5 ft and 2 iron pipes,		2,170 00		2,670 00
Excavation, earth,	20,418 cu yd at 12½ ct	2,552 25	14,180 cu yd at 12½ ct	1,772 50
Excavation, rock,	2,848 " 80	2,278 40	2,020 " 80	1.616 00
Embankment stone,	8.108 " 50	4,054 00	12,550 " 50	6.275 00
Back filling,	9,664 " 15	1,449 60	10,860 " 15	1,629 00
Back filing,	5,148 " 9	463 32	8,950 " 9	805 50
Road crossing,		350 00		475 00
	Total,	$13,417 57		$15,343 00

TWENTY-SECOND MILE—Sidehill near the Hudson, between Greensburg and Yonkers.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		350 00		350 00
Culverts, viz: 2–5 ft and 2 iron pipes,		1,150 00		1,450 00
Excavation, earth,	20,540 cu yd at $12\frac{1}{2}$ ct	2,567 50	14,280 cu yd at $12\frac{1}{2}$ ct	1,785 00
Excavation, rock,	3,360 " 80	2,688 00	2,460 " 80	1,968 00
Embankment stone,	2,310 " 50	1,155 00	2,930 " 50	1,465 00
Back filling,	4,350 " 15	652 50	5,550 " 15	832 50
Back filling,	14,600 " 9	1,314 00	20,700 " 9	1,863 00
	Total,	$9,877 00		$9,713 50

TWENTY-THIRD MILE—Sidehill near the Hudson, above Yonkers.

Grubbing and clearing ground,		350 00		350 00
Culverts, viz: 1–10 ft 3–3 ft and 2 iron drains,		2,236 00		2,845 00
Excavation, earth,	21,220 cu yd at $12\frac{1}{2}$ ct	2,652 50	14,925 cu yd at $12\frac{1}{2}$ ct	1,865 62
Excavation, rock,	4,350 " 80	3,480 00	3,020 " 80	2,416 00
Embankment stone,	5,620 " 50	2,810 00	7,100 " 50	3,550 00
Back filling,	5,252 " 15	787 80	6,730 " 15	1,009 50
Back filling,	16,332 " 9	1,469 88	23,562 " 9	2,120 58
	Total,	$13,786 18		$14,156 70

TWENTY-FOURTH MILE—Sidehill above Yonkers.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$200 00		$200 00
Culverts, viz: 2–3 feet and 1 iron pipe,		720 00		950 00
Excavation, earth,	24,824 c yds at $12\frac{1}{2}$ ct	3,103 00	16,944 c yds at $12\frac{1}{2}$ ct	2,118 00
Excavation, rock,	1,936 " 75 cts	1,452 00	1,455 " 75 cts	1,091 25
Back filling,	16,105 " 10 cts	1,610 50	16,641 " 10 cts	1,664 10
	Total,	$7,085 50		$6,023 35

TWENTY-FIFTH MILE—Entering the valley of Saw Mill River by a deep cut or tunnel, and ascending the the latter by the slope on the north side, towards Morrison's Mill.

Grubbing and clearing ground,		$75 00		$75 00
Culverts, viz: 3 iron pipes,		375 00		450 00
Excavation, earth,	9,652 c yds at $12\frac{1}{2}$ cts	1,206 50	6,820 c yds at $12\frac{1}{2}$ cts	852 50
Excavation, rock,	1,700 " 75 cts	1,275 00	1,250 " 75 cts	937 50
Embankment, stone,			800 " 50 cts	400 00
Drift cutting,	1,028 " $5	5,140 00	1,028 " $5	5,140 00
Back filling,	2,948 " 15 cts	442 20	4,620 " 15 cts	693 00
Back filling,	7,302 " 9 cts	657 18	8,660 " 9 cts	779 40
	Total,	$9,170 88		$9,327 40

TWENTY-SIXTH MILE—Crossing Saw Mill River, and entering the valley of Tibbit's Brook by a driftway of 314 yards—rock.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$300 00		$300 00
Culverts, viz: 2–3 ft.		675 00		800 00
Excavation, earth,	18,040 c yd at 12½ cts	2,255 00	12,628 c yds at 12½ ct	1,578 50
Excavation, rock,	5,612 " 80 cts	4,489 60	4,040 " 80 cts	3,232 00
Stone Embankment,			5,500 " 50 cts	2,750 00
Drift Cutting,	2,200 " $5	11,000 00	2,200 " $5	11,000 00
Back filling,	5,900 " 15 cts	885 00	10,350 " 15 cts	1,552 50
Back filling,	6,500 " 9 cts	585 00	8,375 " 9 cts	753 75
	Total,	$20,189 60		$21,966 75
Aqueduct 160 feet long, including road, arch and wings,		$19,660 00		$19,660 00

TWENTY-SEVENTH MILE—Crossing Tibbit's Brook, and so down the Valley by the east side slope.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$300 00		$300 00
Culverts, viz: 1–10 ft. and 6–3 ft.		3,060 00		3,920 00
Excavation, earth,	13,360 c yd at 12½ ct	1,670 00	9,456 c yd at 12½ ct	1,182 00
Excavation, rock,	3,272 " 80 cts	2,617 60	2,320 " 80 cts	1,856 00
Embankment, stone,	1,936 " 50 cts	968 00	6,320 " 50 cts	3,160 00
Back filling,	12,830 " 9 cts	1,154 70	8,530 " 9 cts	767 70
Back filling,	2,641 " 15 cts	396 00	11,990 " 15 cts	1,798 50
	Total,	$10.166 30		$12,984 20

TWENTY-EIGHTH MILE—Valley of Tibbits' Brook, east side of slope.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$360 00		$360 00
Culverts, viz: 1–5 ft. 2–3 ft. and 2 iron pipes,		1,380 00		1,775 00
Excavation, earth,	17,650 c yd at 12½ ct	2,206 25	11,235 c yd at 12½ ct	1,404 37
Excavation, rock,	1,715 " 80 cts	1,372 00	1,280 " 80 cts	1,024 00
Embankment, stone,	358 " 50 cts	179 00	3,840 " 50 cts	1,920 00
Back filling,	1,750 " 15 cts	262 50	9,060 " 15 cts	1,359 00
Back filling,	12,400 " 9 cts	1,116 00	10,585 " 9 cts	952 65
	Total,	$6,875 75		$8,795 02

TWENTY-NINTH MILE—Tibbit's Brook Valley, east side of slope.

Grubbing and clearing ground,		$360 00		$ 360 00
Culverts, viz: 1–10 ft. 2–3 ft. and 2 iron pipes,		2,210 00		2,570 00
Excavation, earth,	16,900 c yd at 12½ ct	2,112 50	10,510 c yd at 12½ ct	1,313 75
Excavation, rock,	1,639 " 80 cts	1,311 20	1,148 " 80 cts	918 40
Embankment, stone,	1,760 " 50 cts	880 00	6,680 " 50 cts	3,340 00
Back filling,	2,580 " 15 cts	387 00	9,250 " 15 cts	1,387 50
Back filling,	12,745 " 9 cts	1,147 05	12,575 " 9 cts	1,131 75
Road crossing,		430 00		600 00
	Total,	$8,837 75		$11,621 40

THIRTIETH MILE—Tibbit's Brook Valley, east side slope.

ITEMS OF WORK.	Estimate for a close channel.		For an open channel.	
Grubbing and clearing ground,		$100 00		$100 00
Culverts, viz: 2 iron pipes,		275 00		350 00
Excavation, earth,	28,140 c yd at 12½ cts	3,517 50	19,622 c yd at 12½ cts	2,452 75
Excavation, rock,	2,848 " 80 cts	2,278 40	1,295 " 80 cts	1,036 00
Embankment, stone,			3,600 " 50 cts	1,800 00
Back filling,	15,205 " 10 cts	1,520 50	21,160 " 12 cts	2,539 20
Road crossing,		450 00		625 00
	Total,	$8,141 40		$8,902 95

THIRTY-FIRST MILE—Through Bathgate's Plains, nearly level.

Grubbing and clearing ground,		$50 00		$ 50 00
Culverts, viz: 2 iron pipes,		285 00		350 00
Excavation, earth,	16,680 c yd at 12½ cts	2,085 00	10,020 c yd at 12½ cts	1,252 50
Excavation, rock,	1,575 c yds at 80 cts	1,260 00	1,165 c yds at 80 cts	932 00
Embankment, stone,			4,300 c yds at 50 cts	2,150 00
Back filling,	3,110 c yds at 15 cts	466 50	13,223 c yds at 15 cts	1,983 45
Back filling,	15,245 c yds at 10 cts	1,524 50	9,922 c yds at 9 cts	892 98
Road crossing,		420 00		600 00
	Total,	$6,091 00		$8,210 93

THIRTY-SECOND MILE—Passing Fordham Church.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$ 50 00		$ 50 00
Culverts, viz: 1–5 ft and 1–3 ft		750 00		960 00
Excavation, earth,	25,170 cu yd at 12½ ct	3,146 25	17,640 cu yd at 12½ ct	2,205 00
Excavation, rock,	6,420 " 80	5,136 00	4,580 " 80	3,664 00
Embankment stone,	1,320 " 50	660 00	3,420 " 50	1,710 00
Back filling,	4,150 " 15	622 50	3,770 " 15	565 50
Back filling,	15,265 " 9	1,373 85	14,114 " 9	1,270 26
Road crossing,		480 00		620 00
	Total,	$12,218 60		$11,044 76

THIRTY-THIRD MILE—Sidehill near Harlaem River—approaching the Aqueduct—rocky.

Grubbing and clearing ground,		$ 100 00		$ 100 00
Culvert, viz: 1–5 ft		450 00		650 00
Excavation, earth,	18,340 cu yd at 12½ ct	2,292 50	8,682 cu yd at 12½ ct	1,085 25
Excavation, rock,	7,880 " 90	7,092 00	5,610 " 90	5,049 00
Back filling,	8,220 " 10	822 00	11,670 " 11	1,283 70
Road crossing,		550 00		750 00
	Total,	$11,306 50		$8,917 95

THIRTY-FOURTH MILE—Crossing Harlaem River, and along the rocky steep of the west bank.

Items of work.	Estimated for a close channel.		For an open channel.	
Aqueduct 1,250 ft long—Estimated in detail, ...		$415,650 00		$415,650 00
Residue of the Mile:				
Grubbing and clearing ground, . . .		$ 200 00		$ 200 00
Culverts, viz: 1–3 ft		320 00		420 00
Excavation, earth, ...	9,890 cu yd at $12\frac{1}{2}$ ct	1,236 25	6,960 cu yd at $12\frac{1}{2}$ ct	870 00
Excavation, rock, ...	8,430 " 90	7,587 00	5,920 " 90	5,328 00
Back filling, ...	9,100 " 15	1,365 00	10,900 " 15	1,635 00
Back filling, ...	4,180 " 9	376 20	7,450 " 9	670 50
Road crossing, ...		425 00		650 00
	Total, .	$11,509 45		$9,773 50

THIRTY-FIFTH MILE—Passing Mrs. Jumel's—undulating sidehill—rocky.

Grubbing and clearing ground, . . .		$ 75 00		$ 75 00
Culvert, viz: 2–3 ft		640 00		850 00
Excavation, earth, ...	7,520 cu yd at $12\frac{1}{2}$ ct	940 00	5,514 cu yd at $12\frac{1}{2}$ ct	689 25
Excavation, rock, ...	8,980 " 90	8,082 00	6,325 " 90	5,692 50
Embankment, stone, ...	6,820 " 50	3,410 00	16,580 " 50	8,290 00
Back filling, ...	11,900 " 15	1,785 00	18,200 " 15	2,730 00
Back filling, ...	4,084 " 9	367 56	5,320 " 9	478 80
Road crossing, ...		510 00		700 00
	Total, .	$15,809 56		$19,505 55

THIRTY-SIXTH MILE—Crossing to the bank of the Hudson, and reaching the Manhattanville Aqueduct.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground, ...		$ 100 00		$ 100 00
Culverts, viz: 3–3 ft		750 00		1,100 00
Excavation, earth, ...	8,700 cu yd at 12½ ct	1,087 50	5,480 cu yd at 12½ ct	685 00
Excavation, rock, ...	3,340 " 90	3,006 00	2,588 " 90	2,329 20
Embankment, stone, ...	820 " 50	410 00	3,280 " 50	1,640 00
Back filling, ...	5,680 " 15	852 00	5,546 " 15	831 90
Back filling, ...	4,650 " 9	418 50	7,780 " 9	700 20
	Total, .	$6,624 00		$7,386 30
Manhattanville Aqueduct, ...		$205,665 00		$205,665 00

THIRTY-SEVENTH MILE—From the Manhattanville Aqueduct, southerly.

Grubbing and clearing ground, ...		$ 100 00		$ 100 00
Culverts, viz: 1–5 ft 1–3 ft and 1 iron pipe,		850 00		1,275 00
Excavation, earth, ...	10,270 cu yd at 12½ ct	1,283 75	7,700 cu yd at 12½ ct	962 50
Excavation, rock, ...	1,460 " 100	1,460 00	1,060 " 100	1,060 00
Embankment, stone, ...	675 " 50	337 50	2,360 " 50	1,180 00
Back filling, ...	8,750 " 9	787 50	6,960 " 9	626 40
Back filling, ...	4,960 " 15	744 00	4,575 " 15	686 25
Road crossing, ...		530 00		780 00
	Total, .	$6,092 75		$6,670 15

THIRTY-EIGHTH MILE—Following the highest ground—slightly undulating, and generally below the level.

ITEMS OF WORK.	Estimated for a close channel.		For an open channel.	
Grubbing and clearing ground,		$ 100 00		$ 100 00
Culverts, viz: 1 road, 1–5 ft 1–3 ft and 1 iron pipe,		4,075 00		4,765 00
Excavation, earth,	6,530 cu yd at 12½ ct	816 25	5,050 cu yd at 12½ ct	631 25
Excavation, rock,	1,248 " 100	1,248 00	968 " 100	968 00
Embankment stone,	35,980 " 60	21,588 00	52,980 " 60	31,788 00
Back filling,	33,880 " 15	5,082 00	40,430 " 15	6,064 50
Back filling,	2,975 " 9	267 75	4,860 " 9	437 40
	Total,	$33,177 00		$44,754 15

THIRTY-NINTH MILE—Following the highest ground—40 chains very undulating—rocky and generally below the level.

Grubbing and clearing ground,		$ 100 00		$ 100 00
Culverts, viz: 2–5 ft 2–3 ft and 2 iron pipes,		1,740 00		2,250 00
Excavation, earth,	9,684 cu yd at 12½ ct	1,210 50	7,270 cu yd at 12½ ct	908 75
Excavation, rock,	3,760 " 100	3,760 00	2,860 " 100	2,860 00
Embankment, stone,	48,900 " 66	32,274 00	72,600 " 66	47,916 00
Back filling,	31,600 " 15	4,740 00	46,880 " 15	7,032 00
Back filling,	7,060 " 9	635 40	7,060 " 9	635 40
Road crossing,		575 00		680 00
	Total,	$45,034 90		$62,382 15

FORTIETH MILE—Following the highest ground, undulating and below the level.

ITEMS OF WORK.	Estimate for a close channel.		For an open channel.	
Grubbing and clearing ground,		$200 00		$ 200 00
Culverts, viz: 2–3 ft. and 2 iron pipes,		860 00		1,100 00
Excavation, earth,	6,460 c yd at 12½ cts	807 50	5,660 c yd at 12½ cts	707 50
Excavation, rock,	1,125 " 100 cts	1,125 00	985 " 100 cts	985 00
Embankment, stone,	91,616 " 66 cts	60,466 56	115,696 " 66 cts	76,359 36
Arcade of brick, (running yards)	264 " $140	36,960 00		36,960 00
Back filling,	54,736 " 18 cts	9,852 48	76,500 " 18 cts	13,770 00
	Total,	110,271 54		$130,081 86

FORTY-FIRST MILE—Terminating at Murray's Hill Reservoir, undulating and below the level.

Grubbing and clearing ground,		$ 250 00		$250 00
Embankment, stone,	58,520 c yds at 70 cts	40,964 00	58,520 c yds at 70 cts	40,964 00
Arcade of brick, running yards,	110 c yds at $120	13,200 00		13,200 00
Arcade of brick, running yards,	616 c yds at $130	80,080 00		80,080 00
Arcade of brick, running yards,	220 c yds at $150	33,000 00		33,000 00
Back filling,	18,988 c yds at 20 cts	3,797 60	18,988 c yds at 20 cts	3,797 60
	Total,	171,291 60		171,291 60
Reservoir 4 blocks by detailed estimate,		102,933 00		102,933 00

Fraction of the Fortieth Mile to be substituted for the 40th and 41st of the foregoing estimate, in case the Bloomingdale location for the Reservoir should be adopted, viz: 66 chains following the highest range of ground—crossing the Bloomingdale Road at the intersection of the 9th Avenue, and terminating at the Reservoir.

ITEMS OF WORK.	Estimate for close channel.		For an open channel.	
Grubbing and clearing ground, ...		$ 200 00		$ 200 00
Culverts, viz: 2–3 ft and 2 pipe drains,		860 00		1,100 00
Excavation, earth, ...	6,460 c yds at $12\frac{1}{2}$ cts	807 50	5,660 c yds at $12\frac{1}{2}$ cts	707 50
Excavation, rock, ...	1,125 c yds at $1 00	1,125 00	985 c yds at $1	985 00
Embankment, stone, ...	57,120 c yds at 66 cts	37,699 20	81,200 c yds at 66 cts	53,592 00
Arcade of brick, running yards, . .	264 c yds at $140	36,960 00	264 c yds at $140	36,960 00
Back filling, ...	38,536 c yds at 18 cts	6,936 48	61,300 c yds at 18 cts	11,034 00
	Total, .	$84,588 18		104,578 50

SUMMARY OF THE FOREGOING ESTIMATES. COMPOUNDED ESTIMATE.

	Close channel.	Open channel.	13 miles close channel, the residue open.
Dam and reservoir, &c.	$33,617 00	$33,617 00	$33,617 00
1st mile,	18,036 00	11,691 90	18,036 00
2d mile,	10,157 05	6,668 00	6,668 00
3d mile,	10,452 50	9,001 55	9,001 55
4th mile,	9,499 00	6,824 45	9,499 00
5th mile,	14,238 56	10,662 40	14,238 56
6th mile, including drift,	20,585 90	18,449 10	20,585 90
7th mile,	19,346 10	20,506 50	20,506 50
8th mile,including aqueduct,	32,985 49	28,895 44	28,895 44
9th mile,	39,122 30	40,562 30	39,122 30
10th mile,	8,934 00	6,974 75	6,974 75
11th mile,	7,843 50	6,105 35	6,105 35
12th mile,	7,419 70	8,580 87	8,580 87
13th mile,	18,121 02	18,151 77	18,151 77
Aqueduct,	69,840 00	69,840 00	69,840 00
14th mile,	7,649 00	5,993 00	7,649 00
15th mile,	10,952 00	7,448 30	10,952 00
16th mile,	13,265 69	14,762 92	14,762 92
17th mile,	8,960 77	8,600 50	8,600 50
18th mile,	11,478 17	12,432 05	12,432 05
19th mile,	16,539 26	19,611 45	19,611 45
Carried over,	$389,043 01	$365,379 60	$363,830 91

SUMMARY OF ESTIMATES—CONTINUED.

	Close chan	Open channel.	13 miles close channel, the residue open.		
Brought over,	$389,043 01	$365,379 60			$363,830 97
20th mile, ...	12,767 45	13,996 55			12,767 45
21st mile, ...	13,417 57	15,343 00			15,313 00
22d mile, ...	9,877 00	9,713 50			9,713 50
23d mile, ...	13,786 18	14,156 70			14,156 70
24th mile, ...	7,085 50	6,023 35			6,023 35
25th mile, ...	9,170 88	9,327 40			9,327 40
26th mile, including aqueduct, .	39,849 60	32,644 20			41,626 75
27th mile, ...	10,166 30	12,984 20			12,984 20
28th mile, ...	6,875 75	8,795 02			8,795 02
29th mile, ...	8,837 75	11,621 40			11,621 40
30th mile, ...	8,141 40	8,902 95			8,902 95
31st mile, ...	6,091 00	8,210 93			8,210 93
32d mile, ...	12,218 60	11,044 76			11,044 76
33d mile, ...	11,306 50	8,917 95			11,306 50
Aqueduct, ...	415,650 00	415,650 00	Syphon, . .	277,340	415,650 00
34th mile, ...	11,509 45	9,773 50	Difference, .	138,310	9,773 50
35th mile, ...	15,809 56	19,505 55			19,505 55
36th mile, ...	6,624 00	7,386 30			7,386 30
Carried over, .	$1,008,227 50	$989,376 86			$997,970 17

SUMMARY OF ESTIMATE—CONTINUED.

	Close channel.		Open channel.		13 miles close channel, the residue open.			
[Brought over,	$1,008,227	50	$989,376	86			$997,970	17
Aqueduct,	205,665	00	205,665	00	Syphon,	141,600	205,665	00
37th mile,	6,092	75	6,670	15	Difference,	64,065	6,670	15
38th mile,	33,177	00	44,754	15			33,177	00
39th mile,	45,034	90	62,382	15			45,034	90
66 chains to Bloomingdale square,	84,588	18	104,578	50			84,488	18
Terminal reservoir,	102,933	00	102,933	00			102,933	00
Total,	$1,485,618	33	$1,525,442	36	to Bloomingdale square,		$1,196,038	40
94 chains additional to Murray's Hill.	196,974	96	196,974	96			196,974	96
Total,	$1,682,593	29	$1,722,417	32	to Murray's Hill,		$1,693,013	36

APPENDIX No. 2.—Estimate of Grade Work for the King's Bridge Route, commencing at the beginning of the twenty-fifth mile.

TWENTY-FIFTH MILE—Crossing Saw Mill River—generally fair, except short deep cut or tunnel and river channel.

Grubbing and clearing ground,		$ 100 00	
Culverts, viz: 1 road,		1,150 00	
Excavation, earth,	17,184 cu yds at $12\frac{1}{2}$ cts	2,148 00	
Excavation, rock,	3,540 cu yds at 80	2,832 00	
Embankment, stone,	2,376 cu yds at 50	1,188 00	
Drift cutting,	924 cu yds at $5	4,620 00	
Back filling,	4,540 cu yds at 15	681 00	
Back filling,	10,400 cu yds at 9	936 00	
	Total,		$13,655 00
Aqueduct across Saw Mill River,			$71,340 00

TWENTY-SIXTH MILE—From Yonkers, south.

Grubbing and clearing ground,		$ 100 00	
Culverts, viz: 2 iron pipes,		300 00	
Excavation, earth,	17,580 cu yds at $12\frac{1}{2}$ cts	2,197 50	
Excavation, rock,	2,745 cu yds at 80	2,196 00	
Embankment, stone,	3,375 cu yds at 50	1,687 50	
Back filling,	8,800 cu yds at 15	1,320 00	
Back filling,	10,290 cu yds at 9	926 10	
	Total,		$8,727 10

TWENTY-SEVENTH MILE—Below Yonkers—crossing wide hollow.

Grubbing and clearing ground,		$ 50 00	
Culverts, viz: 2 iron pipes,		275 00	
Excavation, earth,	11,576 cu yds at $12\frac{1}{2}$ cts	1,417 00	
Excavation, rock,	3,224 cu yds at 80	2,579 20	
Embankment, stone,	20,150 cu yds at 50	10,075 00	
Back filling,	9,260 cu yds at 15	1,389 00	
Back filling,	11,992 cu yds at 10	1,199 20	
Brick arcade,	100 running yds at $140 00	14,000 00	
	Total,		$31,014 40

TWENTY-EIGHTH MILE—Sidehill above King's Bridge—fair surface.

Grubbing and clearing ground,		$ 120 00	
Culverts, viz: 2–3 ft and 1 iron pipe,		495 00	
Excavation, earth,	21,180 cu yds at $12\frac{1}{2}$ cts	2,647 50	
Excavation, rock,	3,420 cu yds at 80	2,736 00	
Back filling,	13,280 cu yds at 10	1,328 00	
	Total,		$7,326 50

TWENTY-NINTH MILE—Undulating side slope—above King's Bridge.

Grubbing and clearing ground,		$ 200 00	
Culverts, viz: 3–3 ft and 2 iron pipes,		1,080 00	
Excavation, earth,	17,312 cu yds at 12½ cts	2,164 00	
Excavation, rock,	4.884 cu yds at $1	4,884 00	
Embankment, stone,	2,116 cu yds at 50	1,058 00	
Back filling,	6,164 cu yds at 15	924 60	
Back filling,	10,072 cu yds at 9	906 48	
	Total,		$11,217 08

THIRTIETH MILE—Crossing Harlaem River—residue slightly undulating.

Grubbing and clearing ground,		$ 350 00	
Excavation, earth,	14,696 cu yds at 12½ cts	1,837 00	
Excavation, rock,	3,184 cu yds at 80	2,547 20	
Embankment, stone,	7,150 cu yds at 50	3,575 00	
Back filling,	13,400 cu yds at 15	2,010 00	
Back filling,	5,984 cu yds at 9	538 56	
	Total,		$10,857 76
Aqueduct, 17 chains long, 120 ft high, estimated in detail,			$368,800 00

THIRTY-FIRST MILE—Crossing Dry Hollow, below King's Bridge.

Grubbing and clearing ground,		$ 300 00	
Excavation, earth,	18,346 cu yds at $12\frac{1}{2}$ cts	2,293 25	
Excavation, rock,	5,404 cu yds at $1	5,404 00	
Embankment, stone,	7,200 cu yds at 50	3,600 00	
Back filling,	6,656 cu yds at 15	998 40	
Back filling,	17,157 cu yds at 9	1,544 13	
	Total,		$14,139 78
Aqueduct, 11 chains long, 96 ft high, estimated in detail,			$196,040 00

THIRTY-SECOND MILE—Between King's Bridge and Manhattanville—generally fair.

Grubbing and clearing ground,		$ 350 00	
Culverts, viz: 2 iron pipes,		260 00	
Excavation, earth,	19,336 cu yds at $12\frac{1}{2}$ cts	2,717 00	
Excavation, rock,	3,156 cu yds at $1	3,156,00	
Back filling,	15,080 cu yds at 10	1,508 00	
	Total,		$7,991 00

THIRTY-THIRD MILE—Side slope of the Hudson, above Manhattanville, very rocky.

Grubbing and clearing ground,		$ 350 00	
Culverts, viz: 2–3 feet and 2 iron pipes,		875 00	
Excavation, earth,	16,300 c yds at 12½ cts	2,037 50	
Excavation, rock,	7,128 " 100 cts	7,128 00	
Embankment, stone,	640 " 50 cts	320 00	
Back filling,	4,010 " 15 cts	601 50	
Back filling,	7,792 " 9 cts	701 28	
	Total,		$12,013 28

THIRTY-FOURTH MILE—Approaching Manhattanville Valley, ending at the aqueduct.

Grubbing and clearing ground,		$275 00	
Culverts, viz: 1–3 ft. and 1 iron drain,		490 00	
Excavation, earth,	10,098 c yds at 12½ cts	1,262 25	
Excavation, rock,	5,536 " $1 00	5,536 00	
Embankment, stone,	750 " 50 cts	375 00	
Back filling,	8,450 " 15 cts	1,267 50	
Back filling,	2,746 " 9 cts	247 14	
Road crossing,		475 00	
	Total,		$9,927 89
Total from the 25th mile, inclusive, to Manhattanville aqueduct,			763,049 79

Estimate of the same by the Tibbit's Brook route, viz:

25th mile, from the detailed estimate of that route,	$ 9,170 88	
26th mile, from the detailed estimate,	20,189 60	
Saw Mill aqueduct,	19,660 00	
27th mile, from the detailed estimate,	10,166 30	
28th mile, do. do.	6,875 75	
29th mile, do. do.	8,837 75	
30th mile, do. do.	8,141 40	
31st mile, do. do.	6,094 00	
32d mile, do. do.	12,218 60	
33d mile, do. do.	11,306 50	
Harlaem River aqueduct,	415,650 00	
34th mile, from the detailed estimate,	11,509 45	
35th mile, do. do.	15,809 56	
36th mile, do. do.	6,624 00	
Total (by Tibbit's Brook route) from the 25th mile inclusive, to Manhattanville aqueduct,		$562,250 79
Extra length of channel way, 1 mile and 66 chains, say,		94,900 00
	Total,	$657,150 79
Least balance in favor of the Tibbit's Brook route,		$105,899 00

APPENDIX No. 3.—Estimate of the route, entering Tibbit's Brook by the Finger Ends.

th mile, from the detailed estimate of the King's Bridge route, ...	$13,655 00	
ueduct, from the detailed estimate, ...	71,340 00	
th mile, from the detailed estimate, ...	8,727 10	
	Total,	$93,722 10

TWENTY-SEVENTH MILE—Round the Finger Ends.

ubbing and clearing ground, ...				$ 350 00	
lverts, viz: 2–3 ft and 2 iron pipes, ...				625 00	
Excavation, earth, ...	5,830	c yds at	$12\frac{1}{2}$ cts	728 75	
Excavation, rock, ...	6,492	"	80 cts	5,193 60	
Drift cutting, ...	770	"	$5	3,850 00	
Embankment, stone, ...	7,040	"	50 cts	3,520 00	
Back filling, ...	11,960	"	15 cts	1,794 00	
Back filling, ...	1,835	"	9 cts	165 15	
				Total,	$ 16,226 50
Aqueduct crossing Tibbit's Brook, 400 feet long, ...					$76,370 00

Fraction of the 28th mile, viz: 30 chains closing at the end of the 28th mile of Tibbit's Brook line.

Grubbing and clearing ground,		$75 00	
Culverts, viz: 1–5 ft.		430 00	
Excavation, earth,	4,550 c yds at 12½ cts	568 75	
Excavation, rock,	886 " 80 cts	708 80	
Embankment, stone,	420 " 50 cts	210 00	
Back filling,	5,696 " 15 cts	854 40	
Back filling,	1,760 " 9 cts	158 40	
		Total,	$3,005 35
otal of grade work for the route by the Finger Ends,			189,323 95

Corresponding estimate of grade work of the tunnel line.

25th mile, from the detailed estimate, Tibbit's Brook route,	$9,170 88	
26th mile, from the detailed estimate,	20,189 60	
Saw Mill River aqueduct,	19,660 00	
27th mile, from the detailed estimate,	10,166 30	
28th mile, from the detailed estimate,	6,875 75	
Total of grade work,	66,062 53	
Additional length of channel way, 50 chains, say	33,500 00	
	Total,	$99,562 35

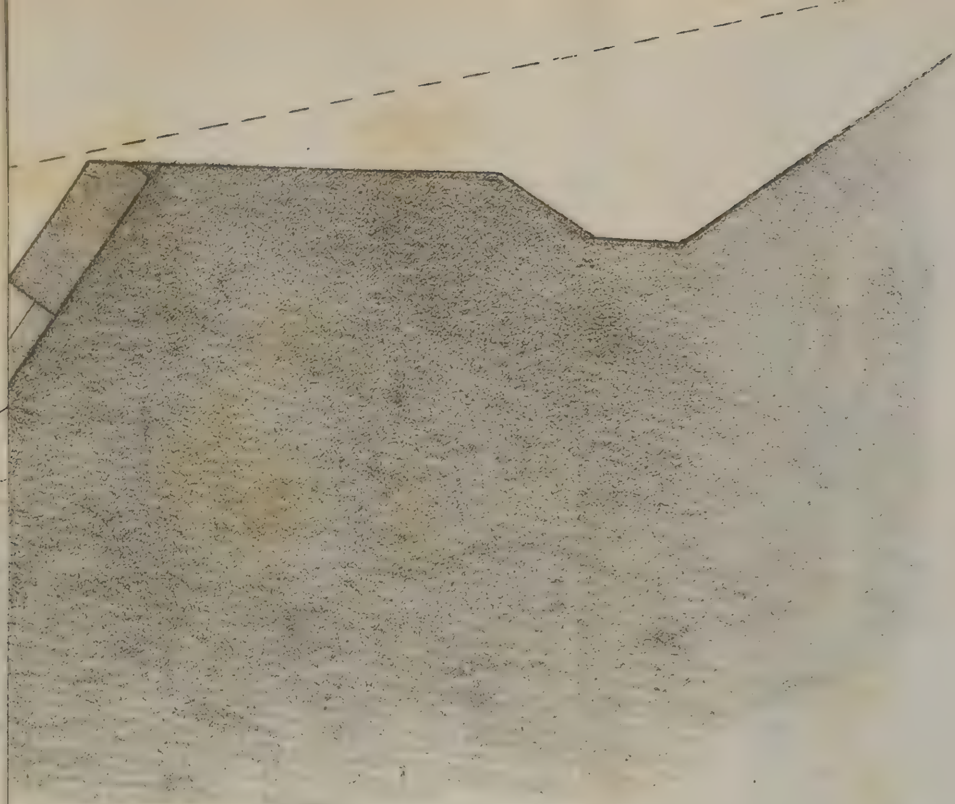
APPENDIX No. 4.

Summary Estimate of grade work for a line from the Croton Dam to the West Chester reservoir, near McComb's Dam, (falling eight inches per mile) and thence by the 8th Avenue to Murray's Hill reservoir.

Dam 34½ feet, ...	$37,120 00
1st mile, ...	18,438 00
2d mile, ...	7,670 80
3d mile, ...	9,811 00
4th mile, ...	10,348 36
5th mile, ...	14,956 28
6th mile, ...	11,304 10
Tunnel, ...	10,045 00
7th mile, ...	21,450 80
8th mile, ...	16,754 00
Aqueduct, ...	14,363 00
9th mile, ...	40,562 00
10th mile, ...	7,766 60
11th mile, ...	7,320 45
12th mile, ...	9,035 00
13th mile, ...	18,700 40
Aqueduct, ...	71,110 68
14th mile, ...	8,356 19
15th mile, ...	11,812 41
16th mile, ...	16,016 00
17th mile, ...	9,560 60
18th mile, ...	13,320 22
19th mile, ...	21,212 44
20th mile, ...	13,704 00
21st mile, ...	16,451 20
22d mile, ...	10,675 88
Carried over, . . .	$447,865 41

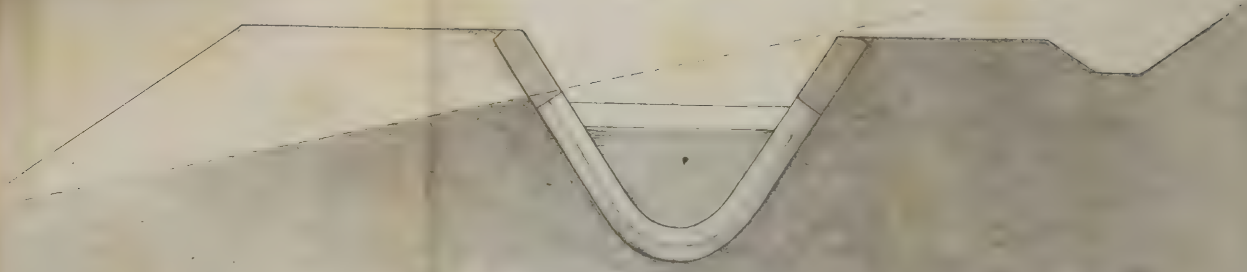
APPENDIX No. 4—CONTINUED.

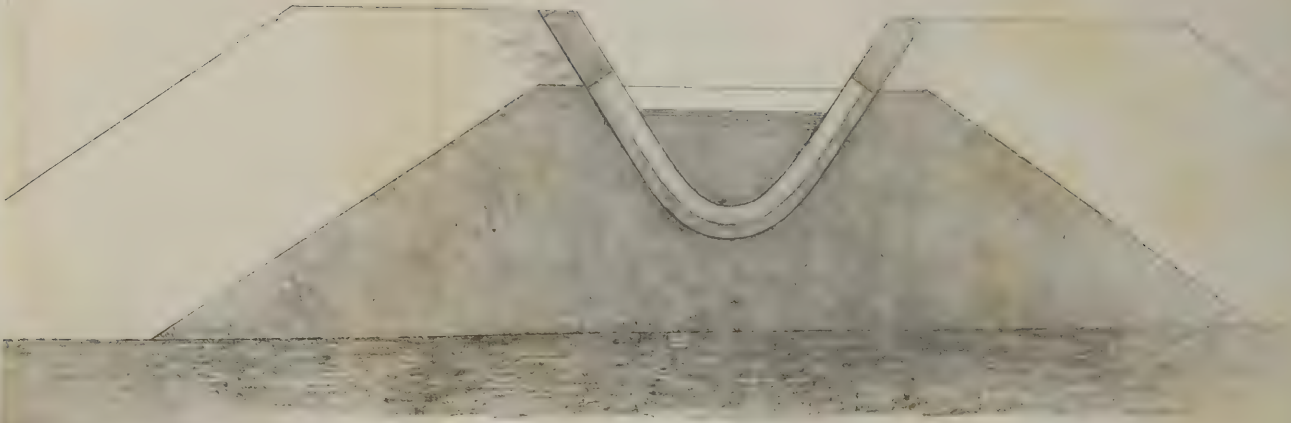
Brought over,	$447,865 41
23d mile,	15,365 00
24th mile,	6,104 00
25th mile,	10,217 71
26th mile,	23,053 18
Aqueduct,	22,440 51
27th mile,	14,148 00
28th mile,	8,850 22
29th mile,	12,730 09
30th mile,	11,050 00
31st mile,	10,644 83
32d mile,	14,106 10
33d mile,	13,460 48
Half mile and aqueduct,	12,920 22
Reservoir,	56,400 00
	$679,355 75
For rebuilding McComb's Bridge and grading 6½ miles to Murray's Hill,	139,440 00
Reservoir at Murray's Hill,	102,933 00
Total,	$921,728 75

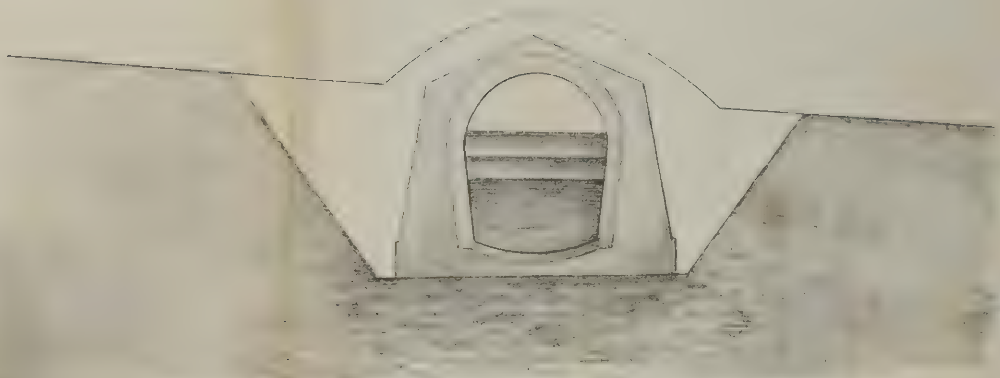


Brought over,	$447,865 41
23d mile,	15,365 00
24th mile,	6,104 00
25th mile,	10,217 71
26th mile,	23,053 18
Aqueduct,	22,440 51
27th mile,	14,148 00
28th mile,	8,850 22
29th mile,	12,730 09
30th mile,	11,050 00
31st mile,	10,644 83
32d mile,	14,106 10
33d mile,	13,460 48
Half mile and aqueduct,	12,920 22
Reservoir,	56,400 00
	$679,355 75
For rebuilding McComb's Bridge and grading 6½ miles to Murray's Hill,	139,440 00
Reservoir at Murray's Hill,	102,933 00
Total,	$921,728 75

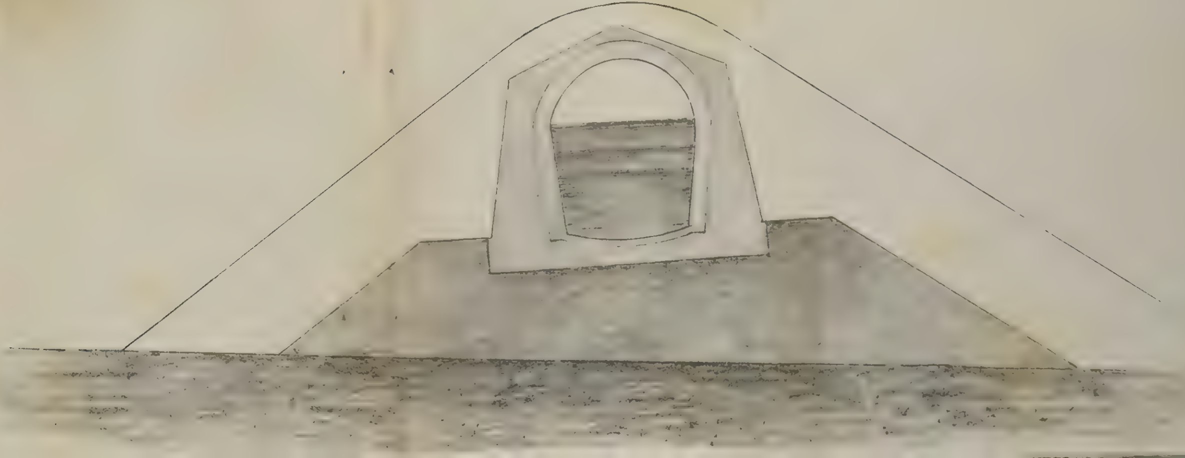
N° 5.







N°8.



MR. MARTINEAU'S REPORT.

Hon. STEPHEN ALLEN, Chairman,
SAUL ALLEY,
BENJ. M. BROWN,
WM. W. FOX, and
CHARLES DUSENBURY, Esqrs. } *Commissioners for making examinations in relation to the supply of New-York with pure and wholesome water.*

GENTLEMEN,

In compliance with your instructions, received the latter part of October, requiring a survey, maps, profiles, &c. relative to the introduction of the waters of the Croton as a supply for the city of New-York, with estimates of the probable cost thereof, I proceed respectfully to

REPORT:

That, after a few days delay, which were employed in obtaining the necessary instruments and collecting a party, the field duties were commenced early in November, at the head of tide water, near the mouth of the Croton, taking as our zero, medium high tide; ascending, directly, the steep bank of the river, 150 feet; a level, at this elevation, was conducted up the left bank of the river to the foot of the rapids, 500 feet below Garretson's mill, where, touching the river surface, it was found to be 123 [illegible]/100, and the surface of water above the mill dam, 136 feet above high tide.

From this point, (which is deemed most favorable for the location of a dam in this vicinity,) a level and traverse, at an elevation of 155 feet, were conducted, following the left bank, up the valley, to ascertain the quantity of land that would be flowed by a dam raised to this height at the aforesaid location; it was found that the surface of a reservoir so formed, would fall within the river banks at a point 3 $\frac{5}{8}$ miles up the valley, above said dam; here the river was crossed, and the margin of the proposed reser-

voir, on the north side of the river, was traced down to the aforesaid dam, near, and just below Garretson's mill.

Resuming our level at the upper extremity of the reservoir just described, we proceeded up to the foot of Muscoot Hill, where the surface of the river was found to be 160 $\frac{50}{100}$ feet above tide; assuming now an elevation of 175 $\frac{75}{100}$ feet, a level and traverse were traced, as before, on both sides of the river, to ascertain how much land would be flowed by a dam at Muscoot Hill setting the water up to this height. It was found, that, at a point about 2 $\frac{1}{8}$ miles above the dam, and $\frac{7}{8}$ of a mile above Mechanicsville, the surface of this reservoir would fall within the banks of the Croton, which was here crossed, and the margin of the flow, on the north side of the river, traced down to Muscoot Hill. This is a favorable place for the location of a dam, the valley here being narrow, at the top line of the dam being only 220 feet, and 18 feet above the bed of the river, which is here rock, as also the north shore, and it is probable that rock may be found near the surface on the south bank of the river, on the removal of the soil.

From the Muscoot dam, a line of location, on the north side of the river, was commenced and conducted down, at a declivity of 15 inches to the mile, to a point about 400 feet below Garretson's mill, where, by an arch of 80 feet span, the line of aqueduct is connected with the south shore of the river, which it follows to its mouth. The distance between Muscoot Hill and the site selected for the proposed arch, which is very near that for the proposed dam at Garretson's mill, is 6 miles. The ground is very favorable for the construction of a line of aqueduct, on any plan, for the whole of this distance, much more so than the same number of miles, taken together, on any part of the rout from Garretson's mill to New-York; no deep cutting or filling is encountered, nor extra cost involved. The culverts required are not large nor numerous. There will be some rock excavation on this section; the stone furnished

from this excavation will be required for protecting slope walls; if an open canal were adopted, and if a work of masonry, in cement, be preferred, still, all the excavated rock would come in use; and on either plan, therefore, no extra cost from the rock met with is likely to occur.

Before proceeding to notice, particularly, our operations below Garretson's mill, it will be proper to state the quantity of land that would be flowed by the Muscoot dam, raised 175 $\frac{75}{100}$ above tide, the damages consequent thereon, to land and other property, and an estimate of the probable cost of its construction, together with the 6 miles of aqueduct, including an arch of 80 feet span, joining on the south shore of the Croton, at Garretson's mill.

The Muscoot dam will flow 117 acres of land, on both sides of the river, taken together, it may be called "good quality," and is estimated to be worth $75 per acre, for

117, is - - - - - - -	$8,775
Flowing the water about 2 feet deep on the wheel of the Mechanicsville Factory, damage estimated at - - - - -	1,000
Contingent damages not included above, say, - - - - - - -	3,352 50
Dam raised 18 feet above the bed of the river, supposed to be constructed in a very substantial manner of hydraulic masonry, 100 feet between the abutments, which are to be raised 8 feet above the tumbling way, these, also formed of massive masonry, are to be connected with embankment of gravel which forms the extreme ends of the dam. The various items entering into this structure, having been separately calculated, are collected in the aggregate of - - -	23,750 29
Contingencies, - - - - -	3,687 77
Total estimated amount of Muscoot dam, including reservoir, and all incidental damages, - - - - - - - -	$40,565 56

Next in order will be stated the probable amount of cost involved in the construction of the 6 miles of aqueduct between Muscoot dam and Garretson's mill, including the arch of 80 feet span, connecting with the south bank of the Croton. The estimate is predicated on the supposition that the channel-way of the aqueduct is formed by a cylinder of masonry 8 feet inside diameter, composed of good stone or brick work, 14 inches thick, well laid with hydraulic cement, and grouted throughout, so as to render the masonry impervious to water. The cylinder to be laid in a trench excavated for the purpose, where cutting is afforded, and where embankment occurs; after it has well settled, a trench is to be formed in the top of it, and the masonry laid as in other cases; the earth excavated to form the trench, both in cutting and embankment, is to be returned back so as to cover over the cylindrical channel-way. The culverts are supposed to be formed of good stone work, in some cases of cylindrical form, and in others, semicircular arches will spring from low abutments, none of them are required to be over 6 feet span, the average about 4 feet. The whole to be executed in a style, and of a quality that will impart to it the character of great durability. Collecting all the items, which have been separately calculated, that form the aggregate cost of this section, the average per mile is $55.161.

and $55·161×6=	$330,966
Aqueduct of 80 feet span, to pass the Croton, and a land arch to pass the road, of 16 feet span, are together estimated at -	53,251
Add Muscoot dam and reservoir, -	40,565 56
Contingencies, - -	21,239 12½
Total estimated cost of Muscoot reservoir and line of aqueduct, including arch landing on the south bank of the Croton, at Garretson's mill, - - -	$446,021 68½

Calculations have also been made, of the probable cost of an open canal channel-way for the proposed acqueduct from Muscoot dam to Garretson's mill, and large enough to admit a clear sectional area of 72 square feet, when running at a depth of 5 feet. The various items entering into, and constituting the cost of a work executed on this plan, have been collected into an aggregate sum, which, for 6 miles of open canal, Muscoot Dam, land flowed, and damages involved, amounts to, including arch of 80 feet, $229,004 54.

The difference in cost, according to the foregoing estimates, between an open canal channel-way, and cylindrical tunnel of masonry, 8 feet in diameter, buried in the earth beyond the reach of frost, from Muscoot dam to Garretson's mill, is $217,017 14. The character of the work, in all other respects, being alike in both cases.

Having ascertained the probable cost of conducting the waters of the Croton from a fountain head, created by a dam at Muscoot hill, the highest point that invited examination in relation to a line of aqueduct by the Croton valley and the margin of the Hudson, the next object of especial interest was to ascertain, from a careful examination into the whole merits of the question, whether a high dam at Garretson's mill, and a line of aqueduct originating at a fountain head thus created, raised high enough to admit of the same declivity as the preceding, that is to say, 15 inches to the mile, might not be found to bear a favorable comparison with it as a starting point for the proposed supply, if not decidedly superior, in its claims for this purpose, to any point higher up.

Assuming an elevation for the dam at this place, suited to the above condition of declivity, adopted previously, from the Muscoot dam, that under consideration must be 168 $\frac{50}{100}$ above tide, and raised 44 $\frac{75}{100}$ feet above the bed of the River, on the rapid 400 feet below Garreston's mill. Our instrumental examinations, based on a line at this altitude, resulted in showing that the whole flats between

Garretson's mill and Muscoot hill would be covered, and a small portion of land above this hill; the water in the channel-way of the river be backed up three-fourths of a mile above Mechanicsville; Pine's bridge would be covered, which, with the roadway leading to it, would necessarily require to be elevated. Garretson's mill establishment, a mill at Crotonville, together with twenty other buildings, would be flowed. The public highway, also, for a great part of the distance, would require to be transferred to higher ground.

The quantity of land that would be flowed by a dam raised to the foregoing elevation, is computed to be 391 acres, mostly of good quality; and, taken altogether, is estimated to be worth $75 per acre.

Then 391 multiplied by 75 gives -	$29,325
Damages to mills and dwellings, some of which are of good quality, but the greater part small and inconsiderable, more or less dilapidated, are, altogether, valued at -	$40,000
Rebuilding Pine's bridge, and embanking roadway to it, estimated to cost - -	$9,500
Contingent damages, to cover improvements other than the buildings before enumerated, - - - - - -	$14,789
Estimated amount of damages to land and buildings, by high reservoir at Garretson's mill - - - - - -	$93,614 00

The dam, as has before been observed, must be raised 44.75 feet above the bed of the river, and $168\frac{76}{100}$ above tide, as the site selected as most suitable for its location. It will be 400 feet long on top line. The south shore and bed of the river are rock. The plan of construction proposed for this dam is briefly described as follows: the central portion, constituting the tumbling way, and the adjacent abutments, to be raised not less than 6 feet higher than the top line of the dam, are supposed to be formed of

good hydraulic masonry, grouted throughout, and rendered impervious to water. The length of dam, between abutments, is 100 feet; abutments, 10 feet thick. Thickness of masonry, on top of dam, 16 feet; up-stream face, perpendicular; down-stream face of dam, sloping at an angle of 60°. The exterior face of the abutments, or wing walls, have juttel walls projecting 8 to 10 feet, so as to form a sound connexion with the embankment, (of which the ends of the dam are proposed to be formed,) protected and supported, on the down-stream side, by a heavy compact slope wall. A dam, so constructed, and made to possess the character of great durability, may be completed for the gross sum of - - - - - - $69,174 70

This being the amount of the various items when collected together.	
Add the estimated amount of damages for buildings, land, &c. as per preceding statement connected with reservoir at Garretson's mill, - - - - -	$93,614 00
Total cost of dam and reservoir at this place, - - - - - -	$162,788 70
Amount of cost to bring the supply from Muscoot rsservoir to the same point, namely, the south shore of Croton river, at Garretson's mill, is - - - -	$446,021 68½
Difference in favor of this position is	$283,232 98

According to the forgoing estimates, of the value of property destroyed by the reservoirs, and cost of the structures connected respectively with them, bringing the supply to the same point in both cases, and at the same altitude, to wit, 168½ feet above high tide, allowing of a declivity of 15 inches to the mill, to the distributing reservoir, 41 miles distant, whose surface will be 117 feet above tide.

Estimated cost of conducting the water from Muscoot

dam, by an open canal, including all expenses, to the same point, to wit, the south shore of the Croton, at Garretson's mill is, - - - - - - - $229,004 54

Estimated cost of dam, reservoir, and damages of every kind, connected with obtaining a fountain head at Garretson's mill, is $162,788 70

Difference in favor of this position for fountain head, instead of Muscoot dam, and open canal, - - - - - $66,215 84

It has before been stated, that a level and survey were traced, designating the boundary of a reservoir that would be formed by a dam at Garretson's mill, raised 155½ feet above tide; this, it was found, would flow the flats more than three miles above the dam, and cover 170 acres of land, nearly all of good quality; Garretson's mill would be drowned out by this dam, and a mill at Crotonville damaged, though not destroyed, together with 10 other buildings, mostly of no great value.

The amount of damages involved in this case, although they fall much below the amount involved by the high dam and reservoir before described, still bore too large a proportion to admit it into the scale of comparison as to relative advantage, all things considered, as the difference in head between this and high reservoir, over 13 feet, was considered of paramount importance, among others, for the following reason, that the head gained would much more than compensate the increased cost of high dam and reservoir, by admitting of a diminished capacity of channel-way to deliver the required supply. Hence, although all the items of cost have been carefully considered and calculated, together with the probable amount of damages to land and other property, involved by the erection of a dam raised to this altitude, it is not deemed necessary to state them, because, after having well considered the relative advantages between a fountain head obtained at Muscoot

Hill, or by a dam at Garretson's mill, creating a reservoir, at an elevation of 155½ feet, or 168½ feet at this last place. The high dam and reservoir are decidedly preferred, as least costly and most efficient for the purpose contemplated.

From Garretson's mill a line of location, with top surface of grade for channel-way at 168 feet above tide, was traced to the head of tide, near Halman's mill, at a declivity of 15 inches to the mile, along the face of side hill, which angle of inclination varies from 10° to 30°. The face of the slope is much broken by ridges and indentations, involving, for short distances, alternately heavy cutting and filling. Still they are generally so short, and balance each other so nearly, that but little extra cost is, on this account, involved. A portion of the excavation will be rock, which can be all used up, either for embankment, slope wall, or in the masonry for culverts, &c. The ground, on the whole, is pretty favorable for the construction of a channel-way for proposed aqueduct, if of masonry; but not so much so for an open canal, which, at so great an elevation, and situated on a surface of so great a declivity as the side hill on the left bank of the Croton is, between the points above named, could not be regarded as quite safe, without being well lined inside, but for a regular channel-way of masonry, occupying much less breadth; the ground on this section of 5 miles, to wit, from Garretson's mill to mouth of Croton, admits of a safe and cheap construction, less than the average between the mouth of Croton and Harlem river.

No culverts of large dimensions are required on this section of the route, nor is their number great; generally. They are contemplated to be formed of masonry, sometimes of cylindrical form, and in some cases semicircular arches.

Before leaving the Croton valley with the line of location, it was deemed important to examine into the feasibility of throwing a dam across the river, at or near the head of tide, and raise a fountain head at once, to an elevation of 150 feet above tide, which would admit of a de-

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clivity of one foot per mile to the distributing reservoir. Two positions offered themselves as suitable locations for the proposed dam, one at the head of the rapid, 500 feet above Halman's mill, 20 feet above tide; the other about the same distance below this mill, where the shores are bluffs of rock 50 feet high, and approach within 75 to 80 feet of each other. The bed of the river is, in both cases, rock. The south shore, in both positions, is very favorable, and either site is remarkably well adapted to the purpose required; should such a plan be thought, on full examination into its merits, to be feasible.

The site to which the following estimate is applied, is that at the head of the rapid above the mill. The height of the dam here would be 20 feet less, but the length would be increased in a corresponding ratio. The length of the top line of a dam in this place would be 700 feet; while the top line of a dam, at the lower site, would be only 500 feet. The peculiar features of the localities in question are such as to render it probable that the cost would not materially vary for a dam at either place. Following up this examination, a level was conducted, at the foregoing elevation, up the north bank of the Croton, marking the boundary of the proposed reservoir, until it encountered the bold steep banks of the river, near Garretson's mill, where, crossing over, a level on the south side, marking the boundary to the proposed dam, was traced. It was ascertained, by the foregoing examinations, that a dam, raised 150 feet, would back the water of the Croton more than one mile above Garretson's mill, before it is confined within its banks; yet, on account of the near approach of the high grounds to the river, very little land above Garretson's mill would be flowed.

The length of the reservoir, as above supposed, raised 150 feet above tide, would be a fraction over 6 miles, and for the greater part of this distance it would average over 1,000 feet in width. The reservoir formed by a dam raised to an elevation of 168½ feet at Garretson's mill, would

be 8½ miles long, but considerably less in breadth. The quantity of land flowed by the Halman's mill reservoir, would exceed the amount flowed by the Garretson's mill reservoir and that at Muscoot hill added together; yet, on account of the inferior quality of the land, and the number of buildings being two less, damages for land, houses, mills, and factories will not be greater than are incurred by the Garretson's mill reservoir.

The quantity of land flowed by the lower, or Halman's reservoir, is 550 acres; surface of the river included, 150 more; making the whole surface of this reservoir about 700 acres. Much the greater portion of the land is rough and broken, not worth over \$20 to \$25 per acre. A portion is of medium quality, consisting of upland slopes; the residue are flats, not of so good a quality as those higher up the river. The whole may be divided, as to quantity and quality, into the following grades.

134 acres of best quality, estimated at \$70 per acre, - - - - - -				\$9,380
190 do.	medium	do.	\$40	7,600
226 do.	rough, rocky land,	do.	\$20	4,520
Making altogether, for land,				\$21,500

The mills which would be drowned out, are mostly not of much value, except the wire factory. They are

Garretson's grist and saw mill,
Tompkins' do. mill,
Small Fulling do.
do. Saw do. and Wire Factory.

These, including water privileges, land, building, and machinery, are estimated to be worth \$10,000.

Allowing half to be lost, the damage will be	\$5,000
The other mills, exclusive of water privilege and land, are estimated, in the aggregate, to be worth - - - - - -	7,500

12 tenements, some of them in good condition, but most of them small and dilapidated, are altogether, with the surrounding improvements usually found in connection with such buildings and farming establishments, estimated at - - - - - 15,000

Whole estimated amount of damage to mills and houses, - - - - - - $27,500

Estimated cost of dam, built in a substantial manner, of the best materials, composed, in great part, of massive hydraulic masonry, well grouted from bed of river to top of dam, weir, a tumbling-way 100 feet between abutments, and 24 feet wide on top, rendering it a good substitute for the bridge next above it, hereby destroyed; up-stream face of dam perpendicular, the down-stream face formed at an angle of 60°. The abutments are computed to be 20 feet thick, and to extend 6 feet above the face of the tumbling-way, on the down-stream side, and extend from the face of masonry of the up-stream side, at an angle of 45°, provided with juttee walls, extending 10 to 12 feet from face of abutment, next to the embankment, of which the ends of the dam are supposed to be formed, so as to make a sound joining to the gravel, which constitutes the embankment; the whole of which is to be protected by a slope wall, laid dry, of selected stone, 8 feet thick. A plan and elevation of this dam will be given, showing more particularly how it is intended to be constructed, when the maps and profiles accompaying this report are presented. All the items of cost, for a dam of the dimensions and mode of construction contemplated in the foregoing description, have been separately calculated, and being collected, constitute the following aggregate sum of - $216,200

Estimated cost of raising and rebuilding Tompkins' Bridge, - - - - $5,000

Fowler's Bridge, at the wire factory, may

be dispensed with, damage therefor, estimated at - - - - - - - $5,000

Total estimated cost of lower dam and reservoir, - - - - - - $275,200

The water rights, in all the estimates, have been excluded, because the damages to mill property on the Croton will be substantially the same, on whatever plan, or at whatever place the waters of that river may be diverted to furnish the desired supply to the city of New-York. The foregoing remark is held to be just, so far as the mills and factories actually erected, and in operation, are concerned; but not as it respects the effect in relation to the intrinsic value of water rights unimproved, and especially below Garretson's mill, where the fall in the river is much more rapid, and more easily rendered available, and may be considered to possess additional value on that account.

The greatest amount of unimproved water power on the Croton, is near its mouth, where the river passes through the Van Courtlandt estate; on this portion of the Croton, about one half of the whole fall, between Muscoot Hill and the Hudson, occurs; but, on account of the necessary cost required to render this very great water power available, and the deep contracted valley through which the Croton passes, hardly affording building ground on its margin, in some cases the water power may be said to possess but little value.

If, however, the proposed dam at Halman's mill should be erected, the case would be very different, the fall of water being concentrated at the head of tide, in connection with the navigable waters of the Hudson, and the side hills falling off at gentle slopes, affording an opportunity of using the water power any where in the vicinity of the dam, or, at very moderate cost, affording a choice of ground of great extent, under circumstances which will allow of using the water over five or six times; by means of which arrangement, the water power of the Croton, even after allowing a large portion of its waters to pass away to sup-

ply New-York, would still be greater than, under other circumstances, the whole volume of the river would afford.

On this plan of drawing a supply from the Croton, the water power would scarcely be diminished, or sustain injury, at least for a long time to come. If the above view of the matter be correct, it follows, that the least amount of damages will be consequent upon a diversion of the Croton river to supply New-York, by raising a fountain head at Halman's mill, and allowing the surplus waters to be used below it, that the case admits of; the proprietor would in this case be benefited rather than injured in his water property.

The foregoing are the esults that have been presented by the survey and examination of the Croton valey; a region of country highly interesting to the citizens of New-York, affording them, as it does, the best, if not the only source, from whence an abundant supply of pure water may be drawn, for their present and future use.

Before leaving the valley of Croton, it may be proper to remark, that although the dam at Halman's would, in one case, be 150, and, if located at the head of the rapid, 130 feet high, it is not on that account impracticable, at a reasonable cost, nor liable, if suitably constructed, to premature decay. The estimate supposes it to be *mainly* formed of hydraulic masonry, laid compact, well bonded, and grouted throughout; nor is it, in relation to its altitude, without a parallel; one at least, of this height, has been constructed in France, and is regarded as a permanent, durable structure. In supplying the city of Edinburgh with water, an embankment, not materially varying, in elevation and other dimensions, from the dam under consideration, was thrown across a deep valley, and is considered as a safe and durable work. There is, indeed, no intrinsic difficulty, apart from the cost in this case, the proper form, dimensions, materials and mode of construction being duly regarded; we may therefore rely with confidence on the practicability of erecting such a structure, even if carried to a greater height.

From what has been said, I desire that it should not lead to the inference of my wishing to urge arguments in favor of a dam at this place, on the plan before proposed. The only object in the examinations relating to it, being that of affording the means of bringing it into a comparison with the other points examined with reference to a starting point, and to express, without hesitation, my own entire confidence in the practicability of the work, regarded as a sound, permanent structure, and the sufficiency of the sum allotted in the estimate to give it such a character, and then leave it, as I shall do all other matters treated of in this report, to its own merits in the estimation of the commissioners, who are, in this case, the proper judges.

It seemed also desirable, in connection with what had previously been done, to try a location originating at a fountain head raised 150 feet above tide, and 5 miles nearer the city, especially as a recent survey had traced a line of location originating from a fountain head at Muscoot Hill, at about the same elevation, and carried to the city at the same declivity as that herein considered as originating at Garretson's mill, at an elevation of 168 feet above tide.

In carrying on this design, it was easy to note the difference at those points of particular difficulty, where heavy cutting and filling cannot be avoided, and by a careful analysis of the data applicable to each, ascertain which, under all the circumstances, was best adapted to the object in view. Along the general face of the sloping ground between the points just alluded to, it was also easy to determine as to the relative advantage due to the respective grades.

This course seemed the more desirable, as, so far as known, no regular instrumental examination, at so low an elevation, had been carried through; it was therefore calculated to contribute more to the general stock of fact, than could otherwise be obtained at so small a cost of time.

Further, it may be proper to remark, that, after a thorough examination into the feasibility of the plan of a high dam

and reservoir at the mouth of the Croton, raising a fountain head 150 feet above tide, and establishing this as the point from which a line of aqueduct may convey the waters of the Croton to supply the city of New-York, the result to which my mind arrived was, that a decided preference was due to this plan, because it would save, according to the estimates with which it compares, nearly $200,000 in cost, and reduce the damage, on the score of water rights, to the lowest possible amount, making the whole difference in its favor about $250,000, on the supposition that the unimproved water power especially benefited, is worth $50,000, between Tompkins' Bridge and the dam in question. The whole fall between these points, nearly 100 feet, being concentrated at one point in connection with the navigable waters of the Hudson, will render the surplus water here of more value than the whole river in its natural state, under the system of detached improvements, is now worth.

With this view of the subject, it was thought advisable to adapt our location, for the line of aqueduct from the Croton to New-York, to this, as the leading plan, and in our progress down with the line of location, to examine the ground in reference to the relative advantage between the high grade, originating from the reservoir at Garretson's mill, and that here proposed, originating from the reservoir at Halman's mill, near the mouth of the Croton. Accordingly, the line of location, which had been traced to this point, was discontinued, by dropping our level $12\frac{25}{100}$ feet, the difference between the two; and our location, thus modified, was continued toward the city.

Near the point of divergence from the Croton, the line crosses a ravine at Col. Hunt's, the extreme depth of which is 42 feet, and width, at line of grade, 300 feet; immediately after crossing this, the line encounters a ridge, smooth in its external appearance, but, from the known formation of this region, a considerable proportion of the excavation through it may be rock, and is so estimated. The highest point of this ridge is 54 feet, and the distance through, 1,200 feet,

beginning and ending with 8 feet; about 800 feet of this ridge, in the estimate, is supposed to be tunnel. Passing out of this deep cut, another ravine occurs, requiring heavy embankment, greatest depth 35 feet, and breadth at grade line, 500 feet; passing this, the line encounters the point of a ridge, whose greatest depth of cut is 28 feet, and distance through, 700. The earth and other material removed from this cut will be required for embankment in passing the last mentioned ravine. The ground now, till we come within a quarter of a mile of Sing Sing, is tolerably favorable; here a ravine, 500 feet wide and 18½ greatest depth, is to be passed; immediately after, a ridge occurs, whose greatest height is 25 feet, and will average 17 for the distance of 1,200 feet; passing onward, the chasm, or deep ravine at Sing Sing, is met with, its greatest depth, at the point passed over, is 96 feet distance across; on line of grade, 276 feet, requiring a culvert of 12 feet span. The line passes through the village without encountering buildings, with deep cutting, sufficient to bury the aqueduct entirely out of view. Between Sing Sing and Sparta a long deep cut occurs, the greatest depth is 52 feet, and for a quarter of a mile will average 32 feet; this deep cut may be avoided by turning the flank of the ridge next the river, but then a sinuous course and heavy embankment would be the result, in passing the intervening valley, by which no saving in cost would be effected. Sparta valley is next passed, it is 650 feet wide in the direction of our course, extreme depression 28 feet; the line now, by a sinuous course, is traced along the undulating side hill of the Hudson river slope, until it comes to a depression in the ridge terminating at the stone church, near Sleepy Hollow; this passed half a mile north of the church, we come to Mill river, which is crossed, as will be seen by referring to the map, near its mouth. This location was finally chosen, after having made several trials to pass this valley higher up. The various courses examined for this purpose, are indicated on the map by red lines. The greatest depression of the ravine or valley oc-

cupied by Mill river, is 68 feet, the breadth, at our grade line, is 840 feet.

We will stop here to remark, that this valley may be passed by a dam, at once, and the waters of Mill river taken into the general supply. The surface of a reservoir that would be formed by such a dam, would probably not exceed 35 acres; it would follow Lewis Carl's mill, (about one mile up the valley from where our line crosses it,) about 4 feet above his present dam; this mill, and Mr. Beekman's below, would be destroyed by this plan, and rendered equally useless by any other mode of turning Mill river into the line of aqueduct; the damage to mill property by diverting Mill river, would be about 10,000. In the estimate, this valley is supposed to be passed by embankment and culvert, the difference in cost will not be material, whether passed by a dam, or by embankment.

Near Tarrytown, another deep ravine occurs, whose breadth is 700 feet, and greatet depth 22 fee. Passing on, through the upper part of the village, no difficulties are met with till we come to a point about 2 miles south, where a valley 1,800 feet wide occurs, whose greatest depression is 16 feet. Continuing onward, one mile north of Dobb's ferry, a ravine is met with, 400 feet on line of grade, and 43 feet greatest depth, next, at the landing; another ravine, 500 feet broad, and 52 greatest depth, is passed over; tracing our line onward, over the undulating side hill slope, no difficulty is met with, until we encounter the dividing ridge intervening between saw mill river; the most favorable crossing place we could find, after ample examination, was by following a depression across the ridge, about 4 miles north of the village of Yonkers. This ridge is the most formidable obstacle to be overcome, on the construction of the proposed aqueduct, that occurs between the Croton and Harlem rivers, its greatest elevation is 66 feet, and for more than half a mile, will exceed 30 feet. Whole length of this deep cut is $\frac{3}{4}$ of a mile; on the estimate, 2,500 feet of this ridge is computed to be tunnel. Saw-mill valley next occurs; its breadth

at the line of grade, is 700 feet, and the surface of the river 24 feet below the surface of aqueduct.

Here we might pass by a dam at moderate cost, by means of which the Saw-mill river might be taken in, to augment the supply; but this plan, at present, is deemed objectionable, principally because it would prematurely divert the water from the valuable mills at and near the village of Yonkers, which would involve heavier damages than the diversion of the Croton itself; while the supply, independent of this stream, will be sufficient for a century to come. The estimate therefore supposes Saw-mill river to be passed by an embankment, and large culvert of 16 feet span.

The line now having gained the western slope of the high land east of Saw-mill river, continues down over favorable ground, with moderate lateral declivity, until it arrives at a point about 4 miles distant, and nearly opposite the village of Yonkers, where a depression in the dividing ridge between Tibbit's occurs, through which, following the course of the public road, it passes into the valley of Tibbit's brook. This valley is proposed to be passed by a dam, to be located near its head, flowing a surface of about 40 acres, bounded by secluded high ground, mostly covered by timber and shrubbery, imparting to the adjacent country the appearance of cleanliness, rendering this a highly eligible position for a storing reservoir, for which purpose, D. B. Douglass, Esq. in his report, recommends it, and in which I entirely concur.

From this storing reservoir, at the head of Tibbit's valley, the line is traced along the western slope of the ridge of high land which terminates at McComb's dam, mostly over favorable ground. Opposite Van Courtlandt's, the line passes through a depression of the ridge, and gains the eastern slope, which it follows till within a short distance of the point deemed most favourable for crossing Harlem river, where, passing through another depression of the ridge, (the highest crest of which is but little above our grade,) it again attains the western slope, which it follows,

converging gradually towards the high lands on the opposite side of Harlem river, till arriving at a point near which the ridge is divided by a deep ravine, about $\frac{3}{4}$ of a mile north of McComb's dam, it crosses this river, whose valley on the line of grade, is 1,320 feet wide, and 940 feet wide at an elevation of 25 feet above high tide; the river is 610 feet wide, skirted on its northern border by a strip of bottom land, 25 feet high and 260 wide.

Having gained New-York island, the line for a short distance is traced along a steep, broken, rocky side hill; leaving this, it attains a more even surface and favorable location to the termination of the high lands north of Manhattanville, where (in the position noticed in the report of D. B. Douglass, Esq.) is very favorable ground for a reservoir, which may be of large capacity. This is the best position for the receiving reservoir, and the point of termination for the line of aqueduct in its ordinary form. From this point it is proposed to conduct the water through iron pipes of large calibre, to a distributing reservoir, located between the 5th and 6th avenues, at their intersection with 38th Street, where our line of location terminated on a smooth elevation, well adapted to the purpose above designated, and probably the best that could be selected.

I omitted to notice in its proper place, that a reservoir for storing and equalizing the supply of water, is proposed to be located half a mile north of the point designated for crossing Harlem river; a very favorable position is here offered, inclosed, in great part, by natural ramparts of rock, and only requiring small expense to render it complete and of large capacity, not less (though it was not measured) than 20 acres, as was estimated.

The reservoir north of Manhattan valley may be of large capacity, serving the threefold purpose of a receiving, storing, and equalizing reservoir. The ground is very favorable for the purpose, the boundary, being already in great part, formed by ridges of rock, leaving only a small part to be artificially constructed of earth and masonry. As

large a surface as can conveniently be inclosed for this reservoir, should be secured, because land here is of less value than nearer the city.

Between this receiving reservoir and that proposed at 38th Street as a distributing reservoir, no other is deemed necessary at present, at least the more especially if the iron pipe connecting the two be of the capacity herein recommended, namely, 6 feet diameter; this large size of pipe will also render it unnecessary to have the surface of the distributing reservoir so large as is recommended in the report of D. B. Douglass, Esq. One half of the capacity he recommends is deemed sufficient, occupying only one block of ground.

The reservoirs herein recommended, connected with the storing and distribution of the water, are the following, to wit: 1st, at the head of Tibbit's valley; 2d, half a mile north of the crossing of Harlem river; 3d, main receiving reservoir, near the extremity of the high ground north of Manhattanville, where the channel way of aqueduct in masonry ends; and 4th, the distributing reservoir, between 5th and 6th Avenues, at their intersection with 38th Street. These are deemed amply sufficient, taken together their; surface is over 80 acres. The lower three are within $8\frac{1}{2}$ miles extreme distance, and the full capacity of the aqueduct is maintained to the receiving reservoir near Manhattanville; from that to the distributing reservoir 6 feet pipe is proposed, which will be capable of delivering three times the amount required, every 24 hours, by the present population of the city. Under this arrangement, therefore, no fears need be entertained as to the sufficiency and promptitude of the supply, on any emergency likely to arise.

Returning from the digression relative to reservoirs, I will here remark, that a line was run from the reservoir near Harlem river, following the ridge to McComb's dam, crossing the river at this place, and uniting with the other, north of the receiving reservoir. The object in view in doing this, was to ascertain how far our grade could be

supported in approaching McComb's dam, and 2d, to obtain data for forming a comparative estimate of the probable cost of passing Harlem river at this point, connecting with the reservoir near Manhattanville, or continuing across Manhattan valley by means of iron pipes connecting with a reservoir south of this valley, and thence to the distributing reservoir. This done, on the 3d of January inst. the field duties of the survey were closed and the party disbanded, well pleased at being released from labors which, during a part of the time, were necessarily connected with severe exposure to inclement weather. It is due to them to bear testimony to the faithfulness and unremited diligence manifested in the discharge of their respective duties.

This line is exhibited on the map, but the merits of this place did not, on reflection, entitle it, in my mind, to be made the subject of a separate estimate.

The whole distance from Muscoot dam to distributing reservoir, omitting fractions, is 47 miles, subdivided as follows: from Muscoot dam to Garretson's mill, 6 miles; from this to Halman's mill at mouth of Croton, 5 miles; thence to the receiving reservoir, 30½ miles; and 5½ from that to the distributing reservoir.

Recapitulation.

From Muscoot dam to distributing reservoir is				47 miles.
From Garretson's	Do.	Do.	Do.	41 Do.
From Halman's	Do.	Do.	Do.	36 Do.

of which 5¾ miles will be iron pipe of large capacity. The inverted syphon, ¼ of a mile long to pass Harlem river, is computed to be 8 feet diameter, made of wrought iron, ½ inch thick; the remaining 5½ miles from the receiving to the distributing reservoir, is computed to be 6 feet in diameter; the estimate supposes this to be cast iron, ¾ of an inch thick. It might be made of wrought iron of this size, at about the same expense as if of cast metal.

Should the high grade line of aqueduct be adopted, originating at Garretson's mill, the capacity of channel way suited to this declivity, and adapted to the delivery of the ordinary summer flow of the Croton, is computed to be equal to 50 feet area, of a cylindrical form, $8\frac{50}{100}$ feet diameter. Thickness of its inclosing walls, 14 inches, formed of good hydraulic masonry, and well grouted throughout.

If the low grade of one foot to the mile be adopted, a cylinder 9 feet in diameter is recommended as of suitable capacity to deliver the required supply, to be formed in the same manner as the preceding. These dimensions and form are considered best under the circumstances supposed, either of these cylindrical channel ways, if lying in a direct line, would deliver about 60,000,000 of gallons in 24 hours, but owing to the very circuitous course the aqueduct must take, one third of this quantity is deducted, and 40,000,000 gallons taken as the quantity they respectively are capable of delivering daily into the distributing reservoir.

Having gone through with a general description of the country traversed by the proposed line of aqueduct, and explained the outlines of the design, or plan proposed for introducing an ample supply of water into the city, especially as regards the channel way, its dimensions, form, and mode of construction; and also treated of the length and sectional dimensions of the iron pipe, and the system of reservoirs, before we proceed to state estimates of the probable cost involved in executing this design, it will be proper, in order to render the description of the remaining parts of it more intelligible, and the whole more complete, that a brief review of the prominent features of the country between the mouth of the Croton and York Island be taken, and, as we pass along, to explain what was omitted in the outline before given, and particularly how those points involving peculiar difficulty, or cost, are proposed to be passed, and the difficulties overcome. This done, the estimates, applicable to the execution of the whole work, will be stated, and the report, after a few concluding remarks, will be closed.

On leaving the mouth of the Croton, the general aspect of the country assumes quite a different appearance, as may readily be inferred from the sketch previously given. Deep cuts and ravines occur in rapid succession, until we pass the valley of Mill river, involving great extra cost, which cannot be avoided by any mode of construction, or materially varied by a few feet difference in the elevation of the grade. This remark is, to a great extent, true, in relation to the whole route, as will more readily appear by a reference to the maps, profiles, and drawings herewith presented. By these it will be seen, that, in some instances, the low grade, originating at the Halman dam, and the high grade, originating at Garretson's mill, pass ridges and vallies at the same points; in others, a variation, adapted to the peculiar features of the country, becomes proper. In the first case, the high grade has less deep cutting, but more embankment, making the cost, on striking a balance, about equal to the low grade, with more cutting and less embankment. This is also true in relation to most of the intervening ground passed over, and, if there are exceptions to the above general remark, they are by no means of importance sufficient to give character to the general design.

The whole distance, on the low grade, that it passes through deep cutting, is 10,090 feet: about 3000 of this distance it is proposed to pass by tunnel, and estimated as solid rock; and 2970 lineal feet, also tunnel, but through earth, and lined with a channel way of masonry; the residue is supposed to be excavated as an open cut, and the earth and other material returned back upon the masonry.

The aggregate breadth of the ravines and vallies, passed over by the line of aqueduct, is about 9500 feet. The mode of passing these, is proposed to be by solid embankments, formed of the excavated rock and earth from the adjacent deep cuts, as far as it will go, and the residue supplied from contiguous grounds. The rough stone from the excavation, will go into the body of the embankment;

and that of good quality, selected for the purpose, is intended to be laid in a compact slope wall, resting against and supporting the embankment; imparting to it, in all cases, additional solidity and permanency.

These embankments should be formed early after the commencement of the work, in order that they may have time to settle previously to forming the cylinder of masonry in the top of them; where, as in all other cases, it is supposed to be covered over beyond the reach of frost, being supplied at suitable intervals, with man holes, answering the twofold purpose of giving ventilation, and admitting individuals to pass inside, to clean out any sediment which, in process of time, may get into the channel-way.

The only large arches, contemplated in the whole design, from Garretson's mill to the city, are that of 60 feet span in the embankment crossing Harlem river, presently to be described, and one of 16 feet to pass Saw-mill river. All the valleys and ravines are proposed to be passed by embankments, except Tibbit's brook, where a dam is substituted, and the line of grade maintained to the receiving reservoir in all cases, except in passing Harlem valley, where an inverted syphon is proposed.

The exterior of all the embankments are supposed to be covered by a heavy compact stopes wall. The angle of embankment stopes, generally, are sunposed to be 60°. They are all to be carried up in regular strata, so as to allow of the most uniform settlement.

The ridge intervening between the Hudson and Saw-mill valley is, by far, the heaviest cut that occurs between the Croton and Harlem river; an open cut through it, 12 feet on bottom, and sloping upward, one inch to the foot, would give about 115,000 cubic yards of excavation; but by adopting a tunnel for the greater part of the distance through it, and rock occurs in quantity, but a small portion of the above amount will require to be removed; if the excavation be mainly earth, and a tunnel cut through

where the depth is over 30 feet, the residue worked as a deep cut, and the earth returned back upon the arch, then about half of the above quantity would require to be removed. It is probable that a large portion of the excavation through this ridge may be rock, and it is so regarded in the estimate where the rock, in any case is sound, the channel-way will be formed in it, to the proper size, at once ; and if the surface cannot conveniently be wrought smooth by the process of excavation, the irregularities are to be filled up by hydraulic masonry.

In passing the ridge between Saw-mill river and Tibbit's brook, the excavation is mostly supposed to be rock, about 550 feet of the distance through it is estimated as tunnel ; the residue an open cut.

In passing Harlem river, on any plan, the most costly structure is required, that occurs on the whole line, from Croton river to the city. Several plans present themselves as applicable to this purpose, among which may be noticed, as holding the first rank in the scale of architectural symetry and grandeur, the plan recommended by D. B. Douglass, Esq. in his report, that, of a series of high semicircular arches, supporting the channel-way of the aqueduct, at an elevation of 126 feet above high tide, by means of which he maintains his regular grade across this valley to the main receiving reservoir near Manhattanville ; next, if, indeed, it be not first, in boldness and grandeur of design, is that of a suspension aqueduct. Employing for this purpose strong wire cables, well anchored on either shore, and supported between the two extremes by at least two pillars or towers, which would divide the whole distance across into three spaces, the middle one being about 500 feet. To these wire cables, the aqueduct of wood or metal is to be appended. The lateral vibration to which these long spaces would be subject, is to be neutralized by suitable horizontal bracing, and the whole rendered steady and secure. A warm advocate for this plan is found in Mr. Charles Ellet, Jun. who, although a young engineer,

has already acquired distinction in his profession, and, at no distant period, is destined to the highest rank. This gentleman has personally examined a great part of the works executed on this principle in Europe; and having devoted special attention to these structures, in all their details, is deemed to be well informed on subjects of this class.

Both of the above plans are, doubtless, practicable, at considerable, though not very extravagant cost. Of the two, the suspension aqueduct is much the cheapest; but, as to the relative merits of the two plans, no opinion is here expressed, a decided preference being given to the plan herein recommended, described as follows: A massive embankment, composed, in great part, of rough stone, sloping, below the water, $1\frac{1}{2}$ to 1, or, at an angle of 34°. Above the water, the exterior stone work is to be laid into a compact slope wall, carried up at an angle of 45°, to a line 30 feet above tide. The embankment to be divided into two portions, by placing an arch of 60 feet span in the channel-way, semielliptical in form, to keep open the navigation, and allow a free reflux of the tide. The springing line of the arch to be near water surface, from substantial abutments; these, and the spandral walls, are supposed to be executed in rough range work of hydraulic masonry. The ring-stone of the arch, angle of abutments, wing walls, and coping, to be formed of cut stone. The sheeting of the arch to be of stone, well selected, but not cut; the whole to be laid in water-lime, and well grouted. The embankment is estimated to be 30 feet broad on top, and may answer the two-fold purpose of a roadway across the river, and foundation for inverted syphon, which, as has before been observed, is computed to be 8 feet in diameter, made of wrought iron half inch think, and buried in the top of the embankment.

The culverts required on the line are numerous, though generally not large, except in a few instances. The largest required, is to pass Saw-mill river; this has before been

proposed as of 16 feet span; three of 12 feet, two of 10 feet, four of 8 feet, seven of 6 feet, and the residue of 4 feet and under.

In some cases, these are to be formed of cylindrical masonry; in others, arches, springing from low abutments; and for very small ones, cast iron pipe is proposed instead of masonry. All the culverts, not of iron, are supposed to be formed of hydraulic masonry, and well grouted.

It has before been observed, that the masonry, of which the aqueduct channel-way is formed, is computed to be 14 inches thick, and composed of well selected stone, which are to be well laid with hydraulic lime, and grouted; or the masonry may be of brick, manufactured expressly for the purpose, as was heretofore contemplated by Canvass White, Esq. This plan may be adopted without increasing the cost allotted for this part of the work in the estimates; though I do not mean to say that a cylinder of masonry, of the proposed dimensions, can be as cheaply formed of any kind of hard brick, as of stone from the quarries found at many places in the vicinity of the proposed work; from these, stone of good quality, in any quantity, can be selected for the purpose, and transported to the places where wanted, at moderate cost. If the cylindrical channel-way be formed of stone, well selected, from these quarries, and well grouted, it will be a work of a very enduring character.

A species of beton, such as is used by Mr. Parker in the construction of cisterns, and for other purposes, may be found to be a useful and economical substitute for masonry of stone or brick; though, it is believed, that where good stone occurs in the vicinity of the purposed work, it can be executed with it, as cheap, and in as substantial a manner, as of any other material that can be brought into competition with it; nevertheless, no doubt is entertained as to the entire sufficiency, in point of strength or durability, of this kind of masonry; nor as to its economy, where the material constituting its main bulk can be conveniently

obtained; in such cases, little doubt is entertained of its being the cheapest species of masonry.

In view of the mode of construction above described, and the foregoing dimensions, the separate items involved in the execution of the work, in all its details, have been carefully considered and calculated; these, being collected and classified, make up the following summary:

ESTIMATE.

Whole quantity of excavation, from Garretson's mill to the receiving reservoir, north of Mahattanville, exclusive of the six deep cuts, separately estimated, is as follows:

526,458 cubic yards excavation, at 30 cts.	$157,937 40
$\frac{1}{5}$ estimated as rock, 105,291 cubic yards excavation, $1 40 extra, - - -	147,408 32
In deep cuts, exculsive of tunnel, 91,766 cubic yards excavation, at 50 cts. - -	45,883 00
$\frac{1}{4}$ of deep cut, estimated as rock, 22,941 cubic yards excavation, $1 50, extra, -	34,411 50
Embankment across valleys and ravines supplied, in part, from adjacent deep cuts, 307,825 cubic yards, at 30 cts. - - -	92,347 50
Slope wall, 108,267 cubic yards, at 75 cts.	81,200 25
3000 lineal feet of tunnel, supposed to be excavated through rock, is estimated at $25 per foot, - - - - -	75,000 00
2970 lineal feet of tunnel, supposed through earth, at $5 per foot, - - -	14,870 00
Culverts and waste weirs on the whole line,	108,000 00
	$757,057 72

CROSSING HARLEM RIVER.

Harlem River embankment of rough stone for base, and good stone for slope wall, together, 53,275 cubic yards, at 75 cts.	39,956 25

Embankment of gravel for upper part, 61,217 cubic yards, at 37½, - - -	22,956 37½
Arch of 60 feet span, including coffer-dams and pumping, - - - -	62,325 00
1320 lineal feet wrought iron pipe, 8 feet diameter, - - - - - -	62,500 00
	$187,737 62½

32 miles cylindrical channel-way, 8½ feet in diameter, 14 inches thick, containing 7,451.13 perches to the mile, equal to 238,436.16 perches, at $6, 3¼ miles supposed to be formed in solid rock, - -	$1,430,616 96
5½ miles cast-iron pipe, 6 feet diameter, ¾ inch thick, laid complete, is estimated at $175,000, - - - - - -	962,500 00
Reservoirs, 4 in number, complete, estimated at - - - - - -	175,000 00
Cost of dam and reservoir at Garretson's mill, as before estimated, - - -	162,728 70
Damages for land occupied by line of aqueduct, - - - - - -	25,000 00
Damages for unimproved water rights on the Croton, - - - - - -	50,000 00
Add for contingencies and superintendance, 12½ per cent. - - - -	475,173 85
Total cost of supply from Garretson's mill, - - - - - - -	$4,225,814 85

The following estimate applies to the lower line of aqueduct, originating at the proposed high dam at Halman's mill, near the mouth of the Croton. The same mode of construction is contemplated as the preceding, modified in its dimensions, to suit the conditions required by a smaller declivity; this having only one foot to the mile, and is 9

feet in diameter, of a circular form, as the other. The increased area here given, will compensate for the diminished declivity of grade, and ensure equal efficiency with the 8½ feet cylinder adapted to the upper grade, in the delivery of the required supply. The surface of water, in the distributing reservoir, will ordinarily stand at 114 feet elevation above tide; and if pipes of large capacity be laid from the receiving reservoir, the general elevation of water surface in the distributing reservoir will be several feet higher. The scale of prices adopted in the preceding estimate, is applied to this, the quantities only being different.

Whole amount of excavation from the dam at Halman's mill to the receiving reservoir, is 451,250 cubic yards, at 30 cents per yard,	$135,375 00
' supposed to be rock, 90,250 cubic yards, at $1 40 extra, - - - -	126,350 00
Deep cuts, exclusive of tunnel, 78,657 cubic yards, at 50 cents per yard, - -	39,328 50
¼ of this amount supposed to be rock, 19,664 cubic yards, at $1 50 extra, -	29,496 00
3,000 lineal feet of tunnel, supposed to be cut through rock, cost per foot is estimated as the preceding, $25, - - - -	75,000 00
3,250 feet of tunnel, supposed to be through earth, at $5, - - - - -	16,250 00
Embankment across valleys and ravines, supplied in part from adjacent deep cuts, 263,850 cubic yards, at 30 cents, -	79,155 00
Slope wall against embankment, 92,802 cubic yards, at 75 cents, - - -	69,601 50
Culverts and weirs on the whole line, estimated at - - - - - -	81,000 00
	$651,556 00

Crossing Harlem river, as per preceding estimate, - - - - -	$187,737 62½

27 miles cylindrical aqueduct, 9 feet diameter and 14 inches thick, gives 7,857 perches to the mile, and this for 27 miles, is 212,139 perches, at $6 per perch, -	$1,272,834 00
Dam at Halman's, including all incidental damages, as per previous estimate, is -	269,610 00
5½ miles cast iron pipe, as per preceding estimate, - - - - - - -	962,500 00
Reservoirs, four in number, as before estimated, - - - - - - -	175,000 00
Damages for land occupied by line of aqueduct, - - - - - - -	25,000 00
Do. on account of unimproved water rights,	50,000 00
Add for contingencies 12½ per cent. on the whole, - - - - - -	450,154 70
Total cost of aqueduct from the mouth of Croton, - - - - - -	$4,044,392 32½
Total cost of aqueduct from Garretson's mill, - - - - - -	$4,225,813 65
Difference in favor of the shortest line, from Halman's, - - - -	$181,421 33

The above are, respectively, the estimated amount of expense of bringing the waters of the Croton to a distributing reservoir within three miles of the City Hall. The plan of the work, in all respects, is calculated to ensure permanency and great durability, to deliver the supply in the purest state, in quantity equal to 40,000,000 of gallons per day in the receiving reservoir, and 25,000,000 into the distributing reservoir, and liable, in the smallest degree, to interruption from accidents and contingencies, requiring also the least annual repairing.

The area of receiving and distributing reservoirs are such as, under extraordinary emergencies of demand for water, will yield 100,000,000 gallons promptly, exclusive of the daily flow of the Croton; and if the two storing re-

servoirs north of Harlem river be put in requisition, three times this amount may be had, and applied to any purpose as quick as the mains could pass it. The quantity, then, that may be commanded is ample, the quality good, cost moderate, and the urgency for the supply pressing. Will the citizens of New-York, the commercial emporium of the New World, much longer postpone the enjoyment of so great a blessing, as that which is shown to be within their reach, at so small a cost?

I will here remark, that although the cylindrical form is recommended for the channel-way of the proposed aqueduct, that form is not intended to he rigidly maintained without any variation. Circumstances may, in some cases, require that it should take an elliptical form, sometimes having the transverse diameter horizontal, and in some situations, approaching the storing reservoirs especially, vertical.

The general form recommended is the cheapest, for a given capacity and strength, that can be employed. A line of aqueduct on this plan, therefore, is the most economical, even more so than an open aqueduct lined with masonry of same quality, strength, and capacity, because a cylinder, or ellipse, will inclose a greater area with a given amount of material, and possess the greater strength, being a complete connected form; while, as in the case of an open line of aqueduct, the walls being disconnected at top, an additional thickness is required, to impart the requisite strength to the structure. To sum up the argument in a few words, an open aqueduct, if executed of masonry of same quality, possessing the same capacity and strength as that recommended in this report, it will cost more money, be liable to receive into it more impurities, exposed to more contingencies, and liabilities to interruption in delivering the required supply, and involve a greater amount of annual repairs. This is the settled opinion I entertain, for which reason I have not thought it necessary to state an estimate of this for this form of work, although most of the necessary details had been prepared.

The same remark is applicable to the plan of an open canal without masonry lining its inside. The quantity of excavation and embankment would be considerably increased, culverts much larger, bridges to be kept in repair, and the canal enclosed by a fence. The land required would be more, cost of iron pipes and reservoirs the same In view of all the details of this mode of construction, it was very apparent that it could not be executed for less than two thirds of the amount of the foregoing estimates. From this consideration, and the great objection to a work executed in this form, exposed, as it would be, to great and constant danger, from failure of some of its parts, interrupting the supply, which would be of an inferior quality, at best, from the quantity of filth that would find its way into the canal—these, and other considerations, rendered it, in my view of the matter, unnecessary to present an entire estimate for this plan of aqueduct; a statement in the foregoing part of this report has been given as applicable to a section of 6 miles between Muscoot hill and Garretson's mill, which is far the most favorable portion of ground passed over in the progress of our examinations.

If any other plan than that recommended be adopted, with a view to reduce the cost of construction, that which seems best adapted to this purpose, and withal liable to the least objections among those enumerated, as relating to an open canal without masonry, is the following, to wit, an open canal, walled up on the inside with dry masonry, bottom semielliptical, the depth two-thirds of the width of channel-way. This would give the necessary area of water section, with a much narrower line of excavation and embankment, than the last mentioned plan, shorten the culverts and bridges, reduce the amount of excavation, embankment, &c. required less ground, and probably not require fencing but for a small part of the distance. When the canal passes through deep cutting, the face of the slopes might be protected, either by paving or rampering. The whole course of the canal would require to be well

puddled previously to laying the inside dry walls; and if, in addition, the embankments were also properly protected, the work, in this form, would be the most valuable for the cost, that perhaps could be adopted. This plan, after the one herein before recommended, is decidedly preferred, taking into view relative cost compared with durability. It could be executed at less expense than a simple canal without any stonework, with sloping sides at the usual angle, the same style of execution being observed alike in both cases. But if executed as above described, with exterior slope walls, and paving or rampering the slopes through deep cutting, to prevent the earth from washing into the aqueduct, the whole can be completed for three-fourths of the estimated cost of covered tunnel. The plans in all things being alike, except the channel-way.

Iron pipes could not be brought into the comparison, for the proposed line of aqueduct except at an immense disadvantage. No estimate in reference to this plan has, therefore, been thought necessary. The materials being at hand to furnish one on short notice, as also for the last mentioned plan of open aqueduct, lined with dry masonry, should they at any time be called for.

The maps, profiles, and drawings, herewith presented, will be readily understood, from the explanations they respectively contain. The lines run are indicated on the map by a red trace. The location, as adopted in the estimates, is, throughout the whole course, indicated by a blue trace. The deep cuts and fillings are all exhibited on the profile. Separate maps of the country, flowed by the several reservoirs, on a large scale, are herewith also furnished. These show the buildings flowed, as well as land, bridges, highways. They all contain written descriptions, fully explaining all matters contained in them. Drawings, also, of the several prominent features of the plan, are likewise furnished. These will readily be understood by their accompanying explanations, and need no comment here.

With a consciousness of many imperfections connected with this performance, occasioned partly by the haste in which it has been compiled, and partly from the intrinsic difficulties involved in the inquiries to which it relates, it is respectively submitted by,

Gentlemen,

Your obedient servant,

JOHN MARTINEAU,

Civil Engineer.

New-York, Jan. 25, 1835.

NEW-YORK, November 20th, 1834.

SIR,

IN compliance with your request of October 4th, I have made out the following Table, shewing the number of blocks in each Ward: also, the number of feet front: the number of lots according to the proposed average of 20 feet by 75 feet: the number of lots yet to be gained out of the rivers, and also the number of vacant or unoccupied lots, as shown by the Assessor's books of 1834.

No. of Ward.	Number of Blocks.	Number of feet front.		Number of Lots.	No. of unoccupied Lots, as taken from the Tax Books.	No. of Lots yet to be gained out of the rivers.	REMARKS.
1st.	80	70,952	10	2237	46	102	
2d.	44	40,614	6	1290	9		
3d.	41	39,632	5	1373	31		
4th.	39	40,091	0	1457	20		
5th.	78	69,591	11	2150	132		
6th.	44	44,744	4	1425	35		
7th.	74	85,726	8	2658	609	248	
8th.	65	77,914	7	2859	196		
9th.	120	126,855	2	4458	1295		
10th.	48	51,009	3	1843	35		
11th.	158	216,352	9	8126	3493	465	
12th.	99	152,192	0	6177	2982	938	These Water Lots are about $\frac{1}{3}$ filled.
13th.	48	50,190	5	1746	293	47	
14th.	41	50,448	4	1775	170		
15th.	78	100,023	6	3642	1268		
	1057	1,216,339	8	43,216	10,614	1800	

THE foregoing estimate of the vacant lots, having been taken from the Assessor's books—the lots are about one fifth larger than the average adopted in the general estimate—so that, by reducing them to the said average, we shall have 12,737 for the number of vacant lots.

Likewise, in the estimate of the feet front, is included all the public squares, buildings, &c. as also the number of feet necessarily used, as sides for the corner lots; the same having been deducted from the total, before making the estimate of the number of lots, as shown in the fourth column of the foregoing table.

EDWIN SMITH, *City Surveyor.*

To STEPHEN ALLEN, ESQ.
Chairman of Water Commissioners.

Mr. U. Wenman's Report.

To the Water Commissioners for the City of New-York.

Gentlemen,

In compliance with your wishes, I beg leave to submit to you a report of the plan, and expenses of laying down pipes, branches, and other castings, preparatory to introducing water into our city. In doing which, I can assure you that I do it with much pleasure, knowing, as I do the very many advantages and good effects of having a full and copious supply of that necessary article, good and wholesome water. The saving that it will be to our city, in cases of fire, will be great; as the expenses of the fire department are increasing, and I am sorry to say, that the fire department is declining; and must go down, if there is not kept up a good and efficient supply of water for the extinguishment of fires.

The present expense of the department, will pay the interest of one third of the whole amount of the expenses of laying down the pipes through our city. The many advantages to a city like ours are great; but time will not permit me to point out, nor is it necessary for me to enlarge on that subject, as that will be amply done by much abler and efficient persons, so will proceed with the necessary information as regards plans, expenses, &c.

According to your request, I have made out the estimates from Twenty-Third street, including all the lower parts of the city; you will perceive, by referring to the map, that the Common Council has already laid down, through various parts of our city, between fifteen and sixteen miles, or 80,199 feet of pipe, and nearly the whole of which is the second size, which with branches, stop-cocks, hydrants, and other castings, has cost about $191,994 21, which

with the additional pipes that will be laid the ensuing summer, will reduce the expense of the large plan considerably.

[I will here make mention that the whole of the pipes now down will fully answer, when the city is watered, without any additional expense.]

In examining the map of the city, you will perceive that above Fourteenth-street, every ninth street is laid out 100 feet wide; I have chosen those streets to lay our large pipes leading from the mains.

As the 20 inch mains are coming down the Fourth Avenue, you will, by referring to the map, perceive that I have laid a 16 inch diameter main through Fourteenth-street, to supply the large pipes that run parallel with our city, especially on the eastern section, where water will, in the course of a very few years, be more wanted than any other, on account of the inability of procuring any fit for use on Stuyvesant Meadows. It will also distribute the water through the lower parts more on an equality.

Beside, it will fully supply the sections along the North and East Rivers, which is all important, and to which I have, as you will perceive, paid particular attention; knowing as we all do, the great call for water for the shipping, which is now obtained by water boats from Brooklyn, the quantity used is now very great, as will be seen by refering to page 210, section 55, of the report made by the late Mr. Clinton, which was furnished at the time by me from information which I procured at Brooklyn; the expense of water at that time was $49,945 per year, and from the rapid increase of our city, and the corresponding increase of shipping, we may infer that the sum mentioned, in the course of a very few years, will be doubled; I have, therefore, taken good care to have a full and sufficient supply for future emergencies. In examining the plan, you will also perceive that I have not, after leaving Fourteenth-street, provided for any branches from the 20 inch main, except at distances of about 2,000 feet apart, and then only to communicate with the 12 inch pipe, with a stop-cock between the two pipes, to turn off, or

on the water as the case may require. My object in so doing, is to save expense, and secure a full supply to the lower section of the city, by using the 12 inch pipe as a supplement to the 20 inch, and also to save the heavy expense of large branches to supply the cross streets.

The number of stop-cocks, as you will perceive, are a heavy item in the account, but they are absolutely necessary, and in the end are a great saving; besides giving more general satisfaction to those who take the water, by not having it stopped into large sections when introducing the water into houses, as well as to repair any damage which may occasionally occur.

The fire-plugs or hydrants appear, on looking on the map, to be very numerous, but on close examination you will perceive that in the lower part of the city, are rather closer than up town, the great value of our stores and store-houses require them to be so; and one other important consideration which I will here mention, that is, the lower part of the city being nearly all stores, the Fire Department cannot procure a sufficient number of men to man their engines, which has been the cause of the engines being removed to the upper part of the city, so that there are only two or three engines to protect the whole lower section of the city, and of those few, the fireman live nearly all up town.

The following Table, No. 1, shows the actual length of pipes as being laid through all of the streets, as mentioned in the former part of the report, also the diameters of the pipes, cost per foot, and sum total. No. 2, shows the extra length pipes wanted to make up the deficiencies of the overlaps, which is 6 inches on each joint of pipe; also cost, &c.

TABLE No. I.

Diameter of Pipes.	Quantity in Feet.	Cost per Foot.	Total Cost of Pipes.
20	23,300	$4 50	$104,850 00
16	14,500	3 25	47,125 00
12	87,095	1 95	169,835 25
10	74,875	1 60	119,800 00
6	622,250	85	528,912 50
4	12,000	60	7,200 00
Total	834,020		$977,722 75

TABLE No. II.

Diameter of Pipes.	Quantity in Feet.	Cost per Foot.	Total Cost of Pipes.
20	1,370	$4 50	$6,165 00
16	855	3 25	2,778 75
12	5,175	1 95	10,091 25
10	4,397	1 60	7,035 20
6	36,601	85	31,110 85
4	707	60	424 20
Total	49,105		$57,605 25

There are wanting 1010 fire-plugs or hydrants, which cost, including fitting up, curve pipe, one 4 inch pipe, and wood box, complete, $28 50 per piece, which is, $28,785.

The extra cost of 1614 branches of various diameters, over and above the cost of running pipes is, $16,861,46.

The cost of pipes the Commissioners will perceive, are some of them higher than the Common Council have heretofore paid for them; the present prices I have obtained of the iron founders the present season, and are included in the following table; the cost of castings per ton is $65. Table No. 3, will also show the whole quantity of pipe in feet and miles, also the quantity of fuel to melt the lead, the quantity of lead, with cost; also showing the cost of ditching, laying, and paving the same, with the sum total of cost of pipes.

TABLE No. III.

Diameter.	Cost of Pipes.	Quantity of Pipes.	Total Cost of Pipes.	Cost of Fuel.	Quantity in Miles and Feet.	Quantity of Lead in lbs. neat.	Total Cost of Lead at $5 per 100 lbs.	Cost of Ditching, Laying, and Paving.
20	$4 50	24.670	$111,015 00	$188 50	4.3550	205.575	$10,278 75	$13,815 20
16	3 25	15.355	49,903 75	95 00	2.4795	110.890	5,544 50	6,909 75
12	1 95	92.270	179,926 50	175 00	17.2510	205.040	10,252 00	25,853 60
10	1 60	79.272	126,835 20	132 00	15.0072	140.928	7,046 40	18,232 56
6	85	658.851	560,023 35	750 00	124.4131	732.060	36,603 00	92,239 14
4	60	12.707	7,624 20	12 50	2.2147	10.590	529,50	1,651 91
		883.125	$1,035,328 00	$1,352 00	164.17205	1.405.083	$70,254 15	$158,702 56

It will be seen by the above Table that there is 167¼ miles of pipe.

In the following Table, No. 4, will be shown the diameters and number of stop-cocks that will be requisite, as well as cost of castings, fitting up; also the cost of frames and covers, and wood box, with the quantity of lead to each joint of pipe. Cost of ditching, laying, and paving per foot, and the cost of fuel per mile.

TABLE No. IV.

Diameter.	Quantity Wanted.	Cost of Casting Fitting up with Frames, Cover, &c.	Cost of Stop-Cocks, Complete, Total Amount.	Pounds of Lead required for each Joint.	Cost of Ditching, Laying, and Paving, per Foot.	Cost of Fuel per Mile.
20	10	$286	$2,860 00	75 lb.	56 cts.	$43 50
16	17	191	3,247 00	65	45	35 00
12	81	111	8,991 00	20	28	10 00
10	76	94	7,144 00	16	23	9 50
6	806	61	49,166 00	10	14	6 00
4	38	45	1,710 00	$7\frac{1}{2}$	13	5 00
	1,028		$73,118 00			

Table, No. 5, will show the quantity of pipes, and other castings that are now down, the expense of which are to be deducted from the sum total. It will also show the actual length and cost of pipes; also the additional quantity and cost of pipes for overlaps; the quantity of branches and extra cost over and above the length of pipe; the cost and number of stop-cocks and fire-plugs, with all their fixtures complete; the expense of ditching, laying, and paving; and also of fuel.

TABLE No. V.

Diameter	Cost of Pipes per Foot.	Length of Pipe.	Additional Length for Overlaps.	Total Cost of Pipes.	Quantity of Lead Neat.	Cost of Lead at $5 per 100 lbs.	Total Number of Pipes.	Cost of Ditching, Laying, and Paving.	No. of Stop-Cocks.	Cost of Stop-cocks, per piece.	Total Cost of Stop-Cocks.	Cost of Fuel.	Cost and number of Fire-Plugs.	Cost and number of Branches, &c.
	$			$	lbs.	$		$		$	$			
12	195	48.705	2.860	100,561 50	114.560	5,728 00	51,565	14,438 20	34	111	3,774	$145 00	176 at $28 50, is $5,016.	334 extra, $4,629 49.
10	1 60	18.529	1.115	31,430 40	34.928	1,746 40	19,644	4,518 12	19	94	1,786			
6	85	7.646	451	6,882 45	8.990	449 50	8,990	1,258 60	8	61	488			
		74.880	4.421	138,874 35	158.478	7,923 90	80,199	20,214 92	61		6,048			

RECAPITULATION OF TABLE No. V.

80,199 feet of Pipe, - - - -	$138,874	35
176 Fire-plugs, or Hydrants, -	5,016	00
334 Branches of various diameter,	4,629	49
158,478 lbs. of Lead, at $5 per 100 lbs.	7,923	90
61 Stop-Cocks, - - - -	6,048	00
Ditching, Laying, and Paving, - -	20,214	92
Fuel for melting lead, - - -	145	00
	$182,851	66
Five per cent. allowed for contingencies,	9,142	55
The total cost of Pipes now laid, -	$191,994	21

In drawing this report to a close, I beg leave to remark, that the amount of the pipes and other castings, in the above table, are set down at the present prices of pipes and castings; which, if quoted at the former prices, would reduce the expense considerably; but if, to be laid at the present time, would cost the above sum.

RECAPITULATION.

$167\frac{1}{4}$ miles, or 882,125 feet of Pipes, -	$1,035,328 00
1010 Fire-plugs, or Hydrants, - -	28,785 00
1614 Branches of various diameters, (extra)	16,861 46
1,405,083 lbs. of Lead, at $5 per 100 lbs.	70,254 15
1028 Stop-Cocks, complete, - - -	73,118 00
Ditching, Laying, and Paving, - -	158,702 56
Fuel for melting lead, - - -	1,352 00
	$1,384,401 17
Add 5 per cent for contingencies, -	69,220 05
	$1,453,631 22
Deduct for Pipes, &c. now laid, -	191,994 21
Sum total required, - - - - -	$1,261,627 01

All of which is submitted by yours, respectfully,

UZZIAH WENMAN,

Water Purveyor, city of New York.

New York, Feb. 16, 1835.